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SCHOOL OF ENGINEERING
PRINCETON UNIVERSITY
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MECHANICAL ENGINEERING

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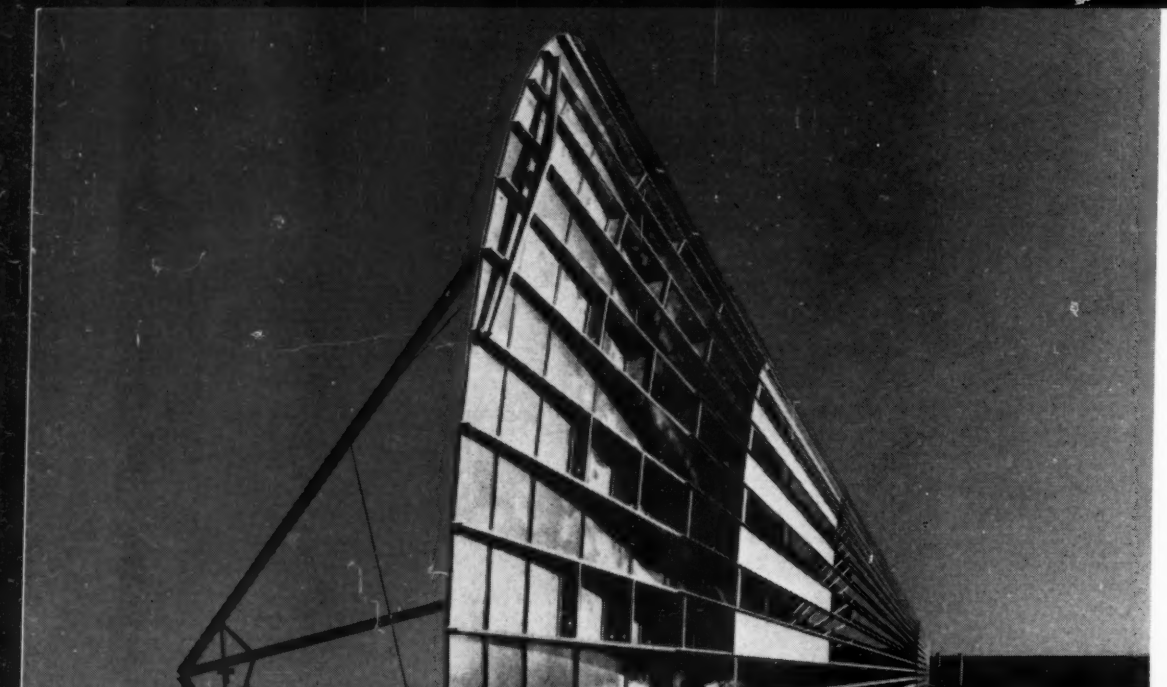

Side view of new 60-ft experimental antenna . . .

. . . largest in the world for super-high frequencies, which can pick up television and telephone signals sent directly through space for 200 miles. Signals are sent over-the-horizon in a transmission technique developed by Bell Telephone Laboratories and the Massachusetts Institute of Technology. This technique is expected to provide longer communications bridges over water and rugged terrain. In the present microwave radio-relay network across the United States, radio-relay stations are 30 miles apart. New antenna is situated on hill at the Holmdel, N. J., site of the Bell Telephone Laboratories.

Editorial

MECHANICAL ENGINEERING

May, 1955, Vol. 77, No. 5 ◆ George A. Stetson, *Editor*

Nuclear Engineering Division

On March 29 a small group of members of The American Society of Mechanical Engineers, under the chairmanship of A. C. Pasini, organized the committee structure of a Nuclear Engineering Division dedicated to the development of the peaceful uses of this new field of engineering.

The new ASME division was authorized by the Council of the Society at the 1954 Annual Meeting on recommendation of the Professional Divisions Committee and the Board on Technology. It stemmed from a petition of the Nuclear Engineering Committee which was set up by the Board on Technology in August, 1954, "for the twofold purpose of co-operating with Engineers Joint Council in planning the participation of ASME in the EJC Congress of Nuclear Engineering and Science (Cleveland, Ohio, Dec. 11–17, 1955) and secondly to study the Society's long-range needs in the field of nuclear engineering and recommend a method of organization within the Society."

Organized interest in nuclear engineering by ASME began years before 1954. Indeed, less than six months after Hiroshima, the Executive Committee of the ASME Council, on Jan. 29, 1946, authorized appointment of a Nuclear Energy Application Committee under the chairmanship of Alex D. Bailey, "to stimulate and develop a continuing program of Society activity dealing with the application of nuclear energy." Because of the nature of the Committee's activities, membership was restricted to persons having the necessary government security clearance. This Committee, composed of members familiar with all phases of nuclear science and engineering, has issued nine sections of a Glossary of Nuclear Science and Technology Terms and has provided many speakers of national prominence for ASME meetings.

In a statement made on Nov. 30, 1954, by Walker Cisler, at that time chairman of the Committee, it was revealed that formation of a professional division devoted to nuclear engineering was considered as early as December, 1947. At that time all matters relating to nuclear engineering were under strict security regulations and the number of engineers competent to discuss the subject was limited. Passage of the Atomic Energy Act of 1954, however, afforded private industry a larger role in development of nuclear energy, technical papers relating to the subject were being presented by several professional divisions at Society meetings, and the 1954 ASME Membership Survey Questionnaire indicated that about 1200 members who responded have a technical interest in this new field. With the great increase of industrial and power projects now under way and the formation of groups of scientists and engineers to provide forums for the discussion of this subject, creation of the ASME Nuclear Engineering Division is a necessary step in keeping the Society and its members abreast with advances in mechanical engineering.

Because of the atom bomb, one of the greatest scientific discoveries of all time, nuclear energy has cast fear of utter destruction into the hearts of men. Fortunately, however, there appear to exist in men and social systems forces of faith in the future and hope for better times to come. As Macaulay observed, "In every experimental science there is a tendency toward perfection. In every human being there is a wish to ameliorate his own condition. These two principles have often sufficed, even when counteracted by great public calamities and by bad institutions, to carry civilization rapidly forward."

Surely it is not fantastic to expect that the remaining years of the twentieth century will record the greatest advances yet made by mankind. The organization of the ASME Nuclear Engineering Division as an agency through which the peaceful application of nuclear energy can be discussed for the benefit, rather than the destruction, of humanity, is symptomatic of the return of science and engineering to their normal productive functions.

The American Society of Mechanical Engineers, now celebrating its 75th Anniversary, was born in the aftermath of a destructive and exhausting war and the dawn of the greatest era of industrial progress the world has yet seen. The mechanic arts were beginning to feel the impact of the physical sciences which had been largely the concern of scholars. Engineering materials were few and only the most elementary facts were known about their physical properties. Techniques of research, testing, and development of new materials were primitive. Even the world's most eminent scientists and engineers could not agree on the best method of developing water power at Niagara Falls. Electricity for arc-lighting was in general use, but the central station, without which we would scarcely know how to live, had not been built.

Today, with the vast horizons being opened in the field which the ASME Nuclear Engineering Division proposes to develop, men are still under the urge of future progress to strive for even greater achievements.

Proposed Program in Ergonomics . . . *Human Engineering*

By Theodore F. Hatch[1]

Professor of Industrial Health Engineering, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pa. Member ASME

In recognition of the need to satisfy human as well as physical and functional requirements in the design of machine tools and other work facilities in industry, it is proposed that the Society set up a program for the development of a branch of engineering, called human engineering, which deals primarily with the human factor in engineering design. As the first step in this development, it is necessary, in co-operation with specialists from the biological and social sciences, to expand the parent field of "ergonomics," on which human engineering rests. Ergonomics is the basic area of applied science which is concerned with the study of human behavior in response to external stress, with particular reference to the stress-strain problems of man at work.

A PRINCIPAL objective in industrial-engineering practice is to provide for the most efficient and beneficial use of human capacities and skills in the conduct of work to yield maximum productivity without imposing undue stress upon the worker. This is accomplished through the selection and design of the most efficient process equipment, machines, and tools, through proper layout of the workplace, and selection of work methods, by substituting mechanical for human power in manual work such as lifting and transporting materials, use of power-driven tools and automatic machines to replace handwork. Attention is given to the working environment, as well as the work facilities; to plant layout, lighting, heating and ventilation, removal of dusts and fumes and, most recently, to noise control. Even the colors in the working environment are selected to give the most pleasing effects. On the human side, highly developed procedures are employed in the selection, placement, training, and supervision of workers to insure the best use of their capabilities and skills with optimum adjustment between the man and his job.

The benefits from these measures have been great, to the industries and the workers alike, and, in consequence, such systematic consideration of human requirements in the arrangement of work facilities and in the organization and operation of industry is now accepted as an essential part of management responsibility and of industrial-engineering practice.

Human Requirements Increase With Complexity of Job

The need to consider human factors in machine and job design has increased in proportion to advances in mechanization of industry. This is the direct consequence of the technological improvements which have been made in the man–job relationship. Thus the elimination of elementary manual labor through mechanization and assembly-line operation has lessened physical stress, but at the same time, has created new work situations involving physiological and psychological stresses of higher order.

In contrast to the handcraftsman, who set his own work pace, the functions of the machine operator and assembly-line worker are more highly organized, impersonal, and repetitive. The individual worker is involved with only a small part of the finished product and, among other consequences, he has lost the feeling of accomplishment which the handcraftsman enjoyed.

There is growing realization in industry of the harmful effects as well as the benefits from mechanization, as evidenced by the current interest in job integration rather than job simplification. To develop a greater feeling of accomplishment and to avoid monotony and repetitive work, individual operators have to perform more complex functions involving simultaneous operations for the production of a completed object or equivalent finished task.

Engineers may take credit for their contribution to the beneficial advances in the use of human capacities in modern industry. These accomplishments have come about through the application of a common-sense approach to the determination of human requirements and the utilization of the same systematic and quantitative procedures of engineering to provide for the human requirements as are employed to meet the physical and functional demands in machine design. In this work, engineers have pioneered in areas of physiology and psychology ahead of specialists in those fields.

It must be recognized, however, that the engineer has accomplished these advances despite his general lack of training in the biological sciences or other areas of study of man. Of necessity, therefore, he has had to limit his considerations to the more elementary aspects of human behavior in response to stress. In this he has

[1] Also Research Advisor, Industrial Hygiene Foundation, Mellon Institute, Pittsburgh, Pa.

Contributed by the Research Planning Committee and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed slightly from ASME Paper 54—A-238.

accomplished much, but ironically, out of the very success of such efforts have come new and more refined human problems which cannot be dealt with in an elementary manner. To solve these problems the engineer must acquire a deeper understanding of man which he has to incorporate into his regular thinking and practice.

Human Engineering Defined

Originally, human engineering had to do with the management of people, with no reference to the physical aspects of engineering. In its popular use, the term lost standing altogether among engineers. It is given a new and specific physical meaning here, however, which should be entirely acceptable. Human engineering is defined as "the application of the principles, laws, and quantitative relationships which govern man's response to external stress to the analysis and design of machines and other engineering structures, so that the operator of such equipment will not be stressed beyond his proper limit or the machine forced to operate at less than its full capacity in order for the operator to stay within acceptable limits of human capabilities."

This definition implies that, to a useful degree, man's anatomical, physiological, and psychological capacities and limitations can be expressed in the systematic terms of engineering and that the nature, source, and magnitude of stresses set up by the machine can be identified and measured and even anticipated in the course of design of a new machine so that the operator will not be subjected to too much stress. Thus in their fullest development, the laws which govern man's working capacities will be applied by engineers on a par with physical laws in engineering practice.

Human engineering rests upon a field of applied science which has been given the name ergonomics, and is defined as "the study of man at work." It draws upon a variety of basic biological and biophysical sciences to define the pattern of human behavior in response to stress and for determining man's capabilities and limitations in dealing with such stress. Contributions have come principally from anatomy, anthropology, physiology, and psychology, and specialists in these areas have taken leading parts in the applications of knowledge from their respective fields to the development of human engineering.

Lack of Engineering Leadership

It is significant to the present discussion that engineers have not had an equal part in this development nor are they using these new principles of human engineering extensively in design.

The possible reasons for this are clear. Much of the information has been prepared and presented wholly within professions essentially foreign to engineers and without the problem of practical application in mind. It is not enough for specialists in other fields, such as physiology and psychology, to prepare statements of capabilities and limitations of man and simply to write specifications for design engineers to follow. The highest degree of teamwork is required in order to develop this field fully. The ultimate objective must be to place in the hands of engineers a set of principles and laws which they can incorporate into their regular practice just as they now draw upon a background of knowledge of the physical sciences. The way in which these laws are to be applied constitutes, of course, a major responsibility of engineers.

In recognition of the need for teamwork in the development of human engineering, British workers have formed the Ergonomics Research Society. Its purpose is to bring together biological and physical scientists who are concerned with the study of man at work and with the application of the principles of ergonomics to the design of work facilities and organization of work. A new society was deemed necessary since interests cut across so many professional lines.

Proposed Program

Since the ultimate application of ergonomic principles must rest with design engineers, we believe that the development of this new branch of engineering specialization should be centered in an established engineering group and specifically, in The American Society of Mechanical Engineers, whose members are closely associated with the problems of concern. A primary objective from the beginning should be to identify for study those engineering problems in which human factors play a major role. Engineers must take an active part in the consideration of research needs, in the design of research studies, and in the practical application of findings from these studies to the solution of the human problems associated with, and created by, mechanization and other technological advances in industry. Engineers will not, of course, take over the primary functions of physiologists, psychologists, and the other specialists in the parent fields, but they must be able to work directly with these other specialists to insure an understanding and wide acceptance of human-engineering principles by engineering colleagues and to make sure that these principles receive primary consideration in design rather than in a secondary status after the physical and functional requirements are met.

To initiate this program it is proposed that the ASME set up a working committee on ergonomics to explore this field, to develop a body of principles, laws, and data for use by design engineers, and to demonstrate the practical usefulness of this area of specialization in the solution of important human problems in industry. This committee should include engineers representing different fields of concern, e.g., industrial engineering, time-and-motion study, methods engineering, machine-tool design, plant layout and building design, health and safety engineering. The ASME should invite specialists from the fields of anatomy, physical anthropology, biomechanics, and various branches of applied physiology and applied psychology to serve on the committee. The immediate objectives would be to define more sharply the nature of human problems which require attention; to bring together existing information on human capabilities and limitations from the parent fields of biological and social science and show how this information can be translated into physical terms for use in engineering design; and finally, to outline the needs for research and joint study of human problems arising out of mechanization in industry so as to establish the fields of ergonomics and human engineering on a firmer and broader basis. It is believed that the work of this committee will contribute in an important way to meeting a recognized need and responsibility in industrial-engineering practice.

Fig. 28 General Electric 4500-hp gas-turbine-electric locomotive operating on the Union Pacific Railroad

Progress in
Railway Mechanical Engineering —1953-1954[1]

Fig. 29 Experimental 300-hp gas-turbine locomotive with twin turbines and mechanical drive built for U. S. Army

Gas-Turbine Locomotives

CHARACTERISTICS of the latest of the fifteen 4500-hp gas-turbine-electric locomotives delivered to the Union Pacific Railroad by General Electric are shown in Fig. 28 and Table 5. The appearance of these units is somewhat different from the ten units (7)[2] which have been operating for the past several years in Union Pacific service. The cab side sheets are recessed to leave an outside servicing walkway with access to equipment through doors in the side sheets. Turbine combustion air and equipment-cooling air are drawn into the cab at roof level.

An altered control system permits of traction-motor excitation from the auxiliary diesel engine-generator set during dynamic-braking periods, permitting complete shutdown of the turbine on long downgrades, with a consequent improvement in fuel economy.

Propane-burning experiments with gas turbine-electric locomotives on the Union Pacific have proved the feasibility of this type of fuel, but the resulting economics aspect has been such as to discourage the substitution of propane for the heavy residuals in the current market price structure.

Fig. 29 pictures a 300-hp double-turbined switching unit with hydraulic drive, built by Davenport under a U. S. Army Transportation Corps developmental authori-

Table 5 Gas-Turbine Locomotives

	Item 1	Item 2
Owner	UP	U. S. Army
Builder	Gen. Elec.	Davenport
Wheel arrangement	B-B-B-B	1-B-1
Service	Freight	Switching
Weight on drivers, lb	574400	50000
Total weight, lb	574400	60000
Length over-all, ft-in	83–6 1/2	24-6
Fuel	Oil	Light oils
Fuel capacity, gal	10600	250
Driving-wheel diameter, in	40	40
Type of drive	Elec.	Hydro-Mech.
Gage, in	56 1/2	56 1/2
Maximum speed, mph	69.3	35
Turbine data:		
Number	1	2
Horsepower	4500	175 (each)
Speed, rpm	6900	....
Manufacturer	Gen. Elec.	Boeing

[1] The first section of this report was published in the April, 1955, issue of MECHANICAL ENGINEERING, pages 308–317.

[2] Numbers in parentheses refer to the Bibliography at the end of the paper.

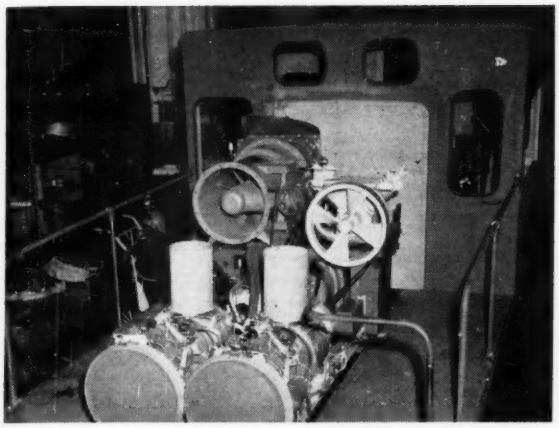

Fig. 30 Twin-turbine installation with auxiliaries for 300-hp gas-turbine locomotive mounted on locomotive platform

zation. Two identical Boeing 150-hp turbines drive through a common gear-reduction unit through a hydraulic torque-converter and gearing to the driving wheels. The wheel arrangement of 2-B-2 results in low axle loading and permits of operation of the unit on light military trackage. Fig. 30 shows the twin-turbine installation with auxiliaries as mounted on the locomotive platform and before the hood compartment has been placed in position.

Research and testing continue on the coal-burning gas-turbine equipment being developed by Bituminous Coal Research and American Locomotive Company at Dunkirk, N. Y. Following the completion of a 750-hr, high-load, high-temperature test on the equipment in 1952, the turbine was partially rebladed and a new design of ash separator was developed with a view to minimizing further blade erosion by ash particles passing through the cleaner. A change was made in the coal-handling system to permit pneumatic handling of fine, dry, pulverized (minus 10-mesh) coal, which is to be furnished from wayside plants thus eliminating coal-preparation equipment on the locomotive. Tests of the new separator with the turbine have shown that consistent performance can be obtained at separation efficiencies considerably higher than those obtained with earlier separators. Inspection of the first-row cylinder blading after a 200-hr load test showed no perceptible erosion. Testing under load conditions simulating locomotive performance is being continued.

Steam-Turbine Locomotives

Last year's report of this committee carried a statistical description with no photograph of the steam turbine-electric locomotive now operating on the Norfolk and Western Railway, and which is the subject of two 1954 papers (8, 9). Fig. 31 shows a view of the locomotive with its water tender. The locomotive unit is claimed to be the longest single locomotive unit ever constructed.

Steam Locomotives

The South African Railways have placed in service a group of 90 condensing steam locomotives built by the English firm of North British Locomotive Company and Henschel & Sohn of Germany. The British firm built all of the locomotives and 30 of the tenders while the remaining 60 tenders were built in Germany.

The nonconventional features of these locomotives have to do with the condensing system and the condenser which is carried on the tender which has an over-all length greater than the locomotive itself.

In the condensing system, exhaust steam from the cylinders is passed through a turbine which drives a blower located in the front end, replacing the conventional exhaust-nozzle drafting system. Steam from the blower turbine is conducted back to the tender through a second turbine which drives five condenser-cooling fans, and thence to the condensing elements.

Fig. 32 illustrates the condensing system diagrammatically while Fig. 33 gives the locomotive detailed dimensions and the over-all length of the engine-tender combination.

A three-cylinder design with Caprotti valve gear built by the British Railways as a standard is shown in Fig. 34.

Two designs, notable for the fact that they are intended for service on Brazilian meter-gage track, are shown in Figs. 35 and 36. A total of 90 units were built by a combination of six French builders. Twenty-five of the 2-8-4 design (a total of 66 were built) are designed for burning wood and the remaining 41 and all of the 4-8-4 design are arranged for burning Brazilian coal of a low Btu content. The 4-8-4 locomotives are stoker-fired while all of the freight units are equipped for hand-firing only. Axle loading is held to a maximum of 28,600

Fig. 31 4500-hp steam turbine-electric locomotive and its water tender for the Norfolk and Western Railway

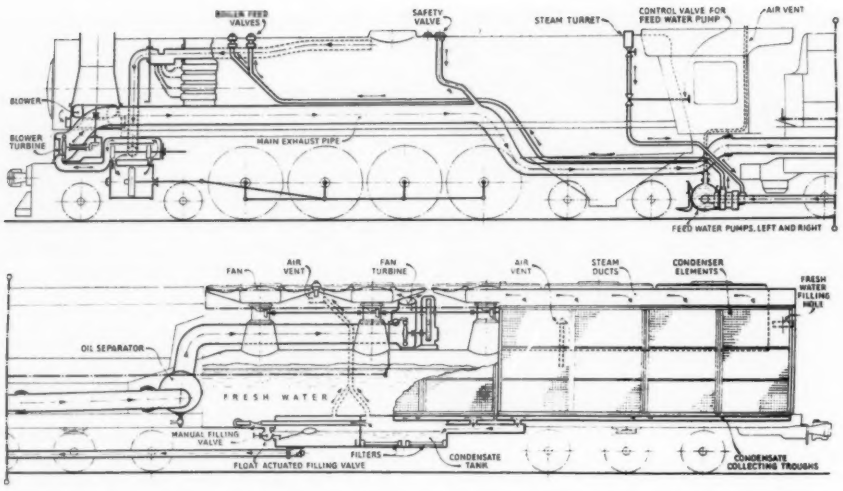

Fig. 32 Diagram of steam and water flow in South African Railways condensing-steam locomotive

lb on the 4-8-4 class while the maximum on the 2-8-4 class is held to 22,000 lb.

Passenger-Train Cars

The outstanding feature in the passenger-car field during the past year was the renewed and increased interest in dome-type cars. A year ago the Milwaukee introduced the first full-length dome car and the past year has produced a number of full-length dome cars as well as several new design conceptions.

Dome Cars for Santa Fe. Fourteen full-length dome cars (Fig. 37) of two types were built for the Santa Fe by the Budd Company. The full-length dome in all cars has 57 nonrevenue coach seats, in addition to an 18-seat lounge area, giving a total seating capacity in the dome of 75. Eight of the cars, which will operate in the "El Capitan" coach train between Chicago and Los Angeles, have on the lower level a nurse's room, a bar and lounge seating 28 passengers. Six cars for operation between Chicago and Oklahoma City have a dormitory for a 12-man crew, a bar, and a small lounge in the lower level. The cars are built entirely of stainless steel. Electric power for lighting, air-conditioning, and auxiliary uses is supplied by a diesel engine-generator set, having 40-kw capacity at 220 volts 3 phase a-c. Air-conditioning equipment utilizes two condensing units with a total capacity of 20 tons. Two 8-ton cooling units are used to supply cooling for the dome and one 4-ton unit cools the lower level. Decorative features of all the cars follow the traditional well-known Santa Fe Indian motif. Six-wheel outside swing-hanger trucks are used. Ready-to-run weights are 191,000 lb.

"Hi-Level" Experimental Cars. Equipment built for the Santa Fe by Budd reveals a wholly new concept of long-distance coach design in two hi-level experimental cars. These cars are not strictly dome cars, but rather a new use of the dome or a variation thereof. They are actually double-deck cars in which all revenue seats are located in the upper or dome level. Through the use of specially designed vestibule diaphragms, passage between the cars will run uninterrupted on the upper level the full length of each car and from car to car. With the same seat spacing as in its standard streamlined coaches which accommodate only 44 to 48 passengers per car the hi-level car accommodates 67 people in rotating reclining seats with adjustable head and leg rests. The lower level includes a midcar entrance way or vestibule, baggage-storage space (there are no luggage racks in the upper level), large rest rooms and all service and auxiliary equipment. A curved stairway connects the entrance way and the lower level with the main passenger compartment on the upper level. Baggage can be stored at the lower level in locked compartments so as to be accessible from inside or outside, thus giving access from the inside en route and permitting passenger and baggage loading and unloading at stations to proceed simultaneously. The service equipment is also accessible from inside or outside the car. The cars are 15 ft high over-all and because the passengers are at a higher level (8 ft 7 in. rail to upper floor) the cars are expected to give a quieter and smoother ride than conventional equipment. Four-wheel outside swing-hanger trucks are used. Fig. 38 shows the exterior of these cars.

Lightweight Parlor-Observation Car. The Southern Pacific rebuilt in its Sacramento shops one conventional lightweight parlor-observation car, originally built in 1937 as a parlor-observation car, into a new bilevel design which they have developed. In rebuilding, the car was increased in length 3 ft. The basic differences between the Southern Pacific design and existing full-length or standard-size dome cars are: (*a*) There are no passenger facilities beneath the upper floor level; and (*b*) the dome or glass roof extends over a part of the interior that is at conventional floor level as well as over the upper level. The dome or glass roof proper is 61 ft $8^3/_4$ in. long. Two thirds of this dome houses the lounge and observation section, containing 28 coach seats and 10 double sofas, on the upper level. The other one third of the dome encloses a cocktail lounge which is on the conventional floor level. The balance of the car floor area, which is also at the conventional level and is not under the dome, houses a service bar and valet quarters. The top of the dome is about 20 in. above the normal car

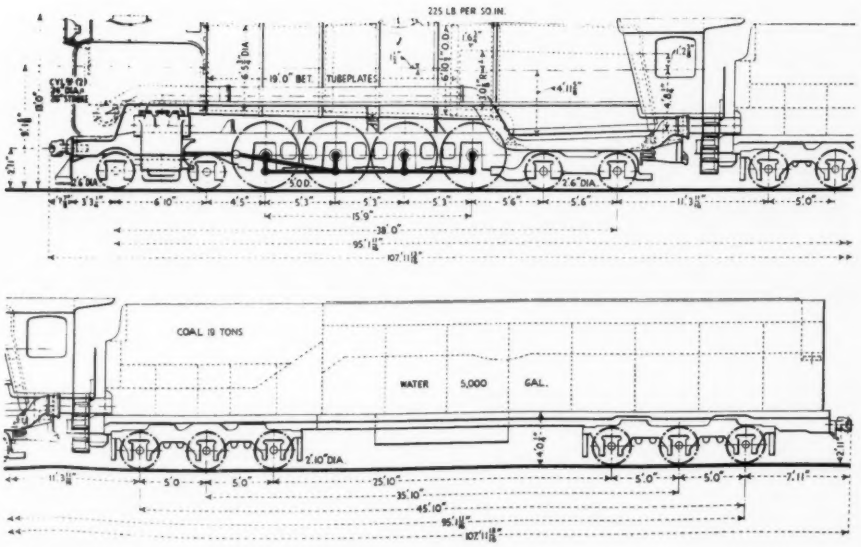

Fig. 33 Detailed dimensions of steam-condensing locomotive-tender combination

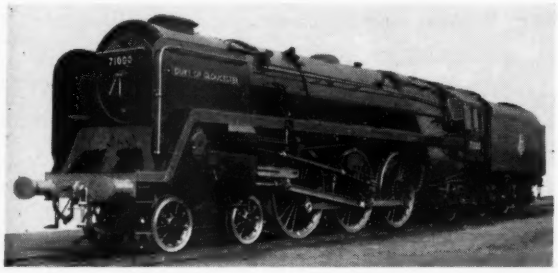

Fig. 34 British Railways standard 3-cylinder steam locomotive with Caprotti valve gear

roof line. The weight was increased from the original 100,000 lb to 156,000 lb. New four-wheel trucks were used. Fig. 39 shows the conventional and upper levels, both under the dome glass.

Northern Pacific Dome Cars. The first of 20 new Northern Pacific dome cars built of stainless steel by Budd have been placed in service between Chicago and the Pacific Northwest. Two types of cars are being built—a dome coach seating 24 in the dome and 46 on the main level and a dome sleeper also seating 24 in the dome but offering four roomettes, four double bedrooms on the conventional level, and four single bedrooms under the dome.

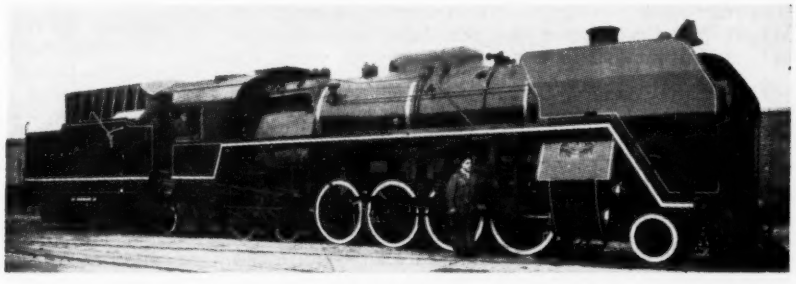

Fig. 35 French-built narrow-gage 2-8-4 locomotive for Brazil

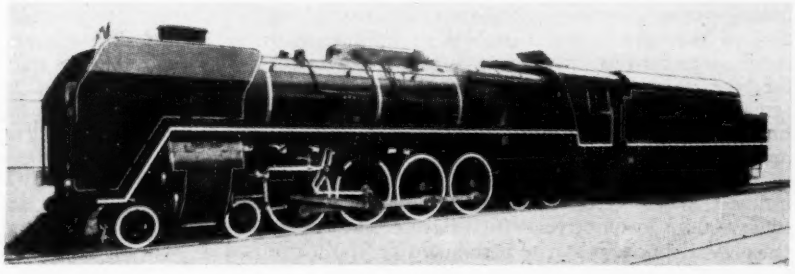

Fig. 36 French-built 4-8-4 for Brazil meter gage

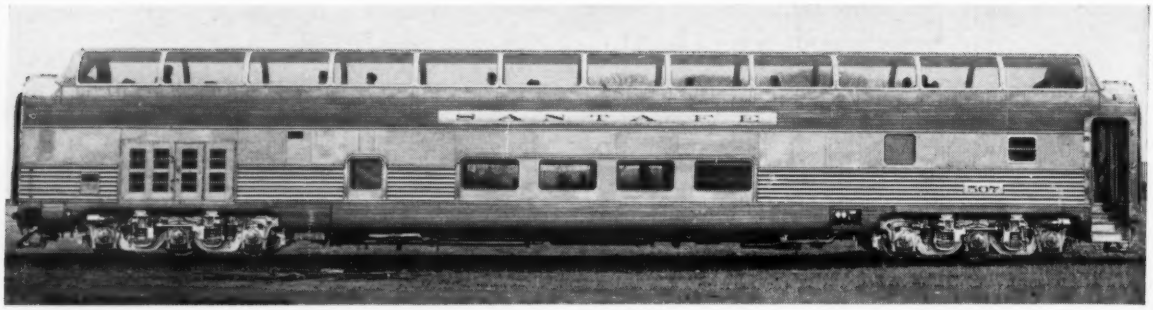

Fig. 37 One of the fourteen full-length dome cars built by Budd for Santa Fe with 75-person seating capacity

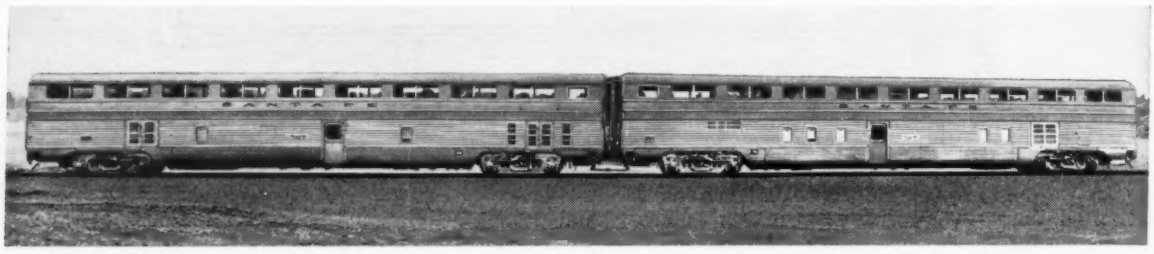

Fig. 38 Experimental double-level cars for coach travel built by Budd for Santa Fe accommodating 67 passengers

Suburban Cars. Pullman-Standard built ten multiple-unit suburban cars at Worcester, Mass., for the Long Island Railroad Company. These cars have a total seating capacity of 128 in three and two-seating arrangements with seats placed back to back. The pairs of seats are 5 ft $4\frac{1}{2}$ in. on centers. The cars are built of low-alloy, high-tensile steel with smooth painted sides. The cars are known as "motorized trailers," indicating that they are equipped with propulsion motors and controls, but contain no cab or engineer's control equipment. The cars were designed with the idea of furnishing a car with a maximum number of seats on one level at a minimum cost per seated passenger. The complete car weight is 121,300 lb and is 80 ft 9 in. long coupled. The interior of the car is shown in Fig. 40.

New Haven Commuter Cars. Early this year the first of an order of 100 new 85-ft multiple-unit cars went into commuter service on the electrified lines of the New Haven. The new cars, built by Pullman-Standard at Worcester, Mass., weigh 163,000 lb light, seat 120 passenger in the three and two walk-over seat arrangement common in the New York area. The cars have a low-alloy steel frame and stainless-steel sheathing, are air conditioned, have automatic heat control, fluorescent lighting, and are designed to give the passenger the maximum comforts in suburban travel. Probably the outstanding feature of the cars is the use of Westinghouse ignitron rectifiers to convert alternating current to direct current for the self-ventilating d-c traction motors. Four ignitron rectifier tubes, mounted on a frame and shock-insulated from the main box, are water-cooled by a closed-circuit cooling system.

The ignitron system has been tested on a trial multiple-unit car in service on the Pennsylvania since 1949 and four 3000-hp locomotives which have been in operation since 1952, but this is the first quantity application of this type of equipment. The ignitron equipment embodies the advantages of high-voltage a-c transmission with the superior characteristics of low-voltage d-c motors. It is particularly well adapted to the New Haven Railroad where the cars operate over the New York Central tracks from the 650-volt d-c third rail between New York and Woodlawn as well as under the 11,000-volt single-phase a-c trolley on the New Haven. The four 100-hp motors accelerate automatically at a fixed rate of 1.0 mph per sec based on average load of 60 passengers. Fig. 41 shows the exterior of the New Haven car.

Canadian Railroad Developments. The Canadian National and the Canadian Pacific Railroads received during the year the first of several large orders for new passenger equipment which represent the first large-scale installation of modern lightweight cars ordered by these roads since the war.

The Canadian National ordered 141 new passenger cars from Pullman-Standard, 218 coaches all alike from Canadian Car & Foundry Company, and 30 baggage cars from the National Street Car Company. The cars are all of high-strength low-alloy steel painted in a new Canadian National two-color scheme. Four-wheel outside swing-hanger trucks are used on all cars. Through careful design studies of the thirteen types of cars built by Pullman, maximum standardization in car arrangements, design details, and even paint colors and fabrics was attained, so that maintenance will be simplified and stocks held at a minimum.

The 218 coaches built by Canadian Car & Foundry Company have 80 seats (28 in a smoking section and 52 in the nonsmoking area). There is a single vestibule, one men's toilet, and two women's toilets. Lightweight is 131,000 lb.

The Canadian Pacific has just received and placed in

service the first of an order of 173 new stainless-steel cars from Budd. One of the new features of these cars is the use of plastic for the walls, thus getting long life with new appearance and a minimum of maintenance.

Stainless-Steel Passenger Coach. A passenger coach (Fig. 42) utilizing stainless steel of 60,000 to 80,000 psi yield strength as the principal structural material was built by Pullman-Standard and delivered to the M-K-T. This car utilizes stainless steel for all of the car-body structure except for heavy or thick-section underframe members and the anticollision post. The design of the car follows very closely the design of the high-tensile steel-girder design of car built by Pullman for many years. Arc welding of stainless to stainless and to low-alloy steel (possible with this strength stainless steel without loss of strength) was used throughout except in attachment of girder and roof sheets which were spot-welded. The weight as delivered was 130,600 lb.

Coaches for National Railways of Mexico. The National Railways of Mexico placed in service a group of 48 first-class coaches, second-class coaches, and mail-baggage cars built in Germany to AAR standards, with reference to buffing draft-gear requirements and general construction to permit operation on occasion on U. S. A. railroads. All coaches are equipped with American-built air-conditioning (Safety Car Heating and Lighting Company) and Vapor Car heating equipment. All cars are 84 ft 6 in. over couplers, 13 ft 6 in. high, with a truck rigid wheelbase of 9 ft 10 in. and an over-all wheelbase of 60 ft. Lightweight of the cars is 132,000 lb. Fig. 43 is an exterior view of one of the second-class coaches.

Heating Tender for South African Railways. For service behind electric locomotives which are not equipped for passenger-train heating, the South African Railways have acquired a new design of heating tender as illustrated in Fig. 44. These tenders are equipped with automatic oil-fired steam generators and are intended ultimately to replace older forms of coal-burning tenders used heretofore.

Dining Cars. In recent years a great deal of study has gone into the design of dining cars and the service methods of preparing and dispensing food to the public. Two innovations were introduced in the past year which indicate some of the thoughts that are being given to the problem.

An innovation introduced recently in passenger cars—automatic food service—is being extended to include an automatic buffet-and-bar car. Six vending machines have been installed in an automatic buffet-bar car on the Pennsylvania Railroad. These provide coffee with or without sugar and/or cream, milk, soft drinks, candy, sandwiches and pastry, as well as cigarettes. The milk, soft drinks, and sandwiches are kept under refrigeration at all times while the "instant" coffee is made fresh for each order. There is also a machine to change coins up to a quarter. Three tables with four seats each are located across the aisle from the vending machine. Only one attendant is used in the car. He runs the bar and makes change for the coin machines.

The New Haven placed in operation a diner with an open kitchen. The all-electric stainless-steel kitchen is open to the public in that there are no partitions between the kitchen and the dining space. The compact kitchen arrangement eliminates unnecessary handling of food and reduces waste and steps, is flexible in operation and in the number of persons required to operate it.

Fig. 39 Interior view of dome car built by Southern Pacific Railroad, showing conventional and upper levels

Fig. 40 Interior of Pullman-Standard nonoperating motorcar for Long Island Railroad suburban service

European Cars. In the 1953 report, self-propelled diesel units built by the German Federated Railways were described. The German Federal Railways last year exhibited at the Munich Communications and Transportation Show, among other things, their latest type of passenger cars offering various arrangements for the three types of travel available in Europe. It was noticeable in most of these cars that the open-compartment coach with the center aisle similar to the cars built in the United States is gaining popularity in Europe over the enclosed compartment coaches with six seats to a compartment.

Freight Cars

The past year has not been a period of high production of freight equipment. However, it was marked by two outstanding trends:

1 The increased tendency to build special cars or to equip cars for the handling of special commodities, particularly where in so doing large laborsaving might result in the handling, loading, and unloading of freight. High-capacity flatcars, covered hopper cars for bulk commodities and loading facilities are still typical of this trend.

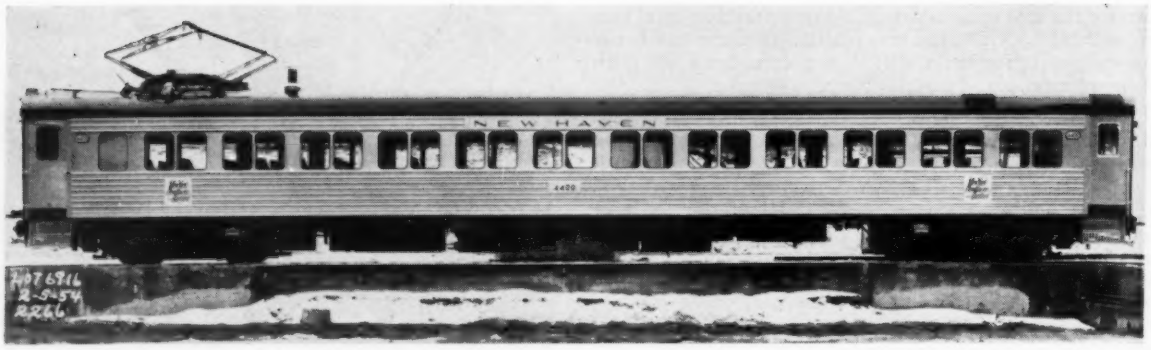

Fig. 41 11,000-volt a-c car for New Haven with rectifier conversion and d-c traction motors built by Pullman-Standard

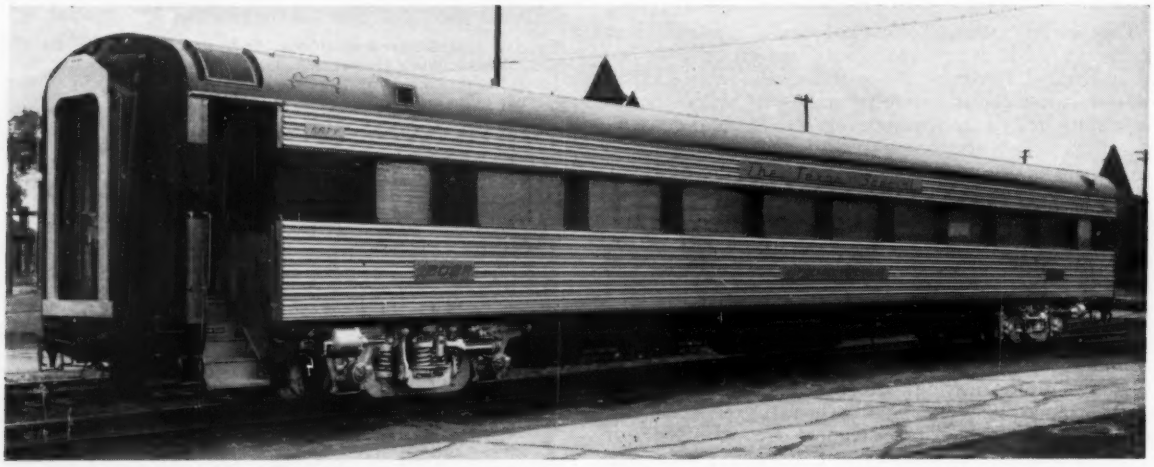

Fig. 42 Pullman-Standard built stainless-steel passenger coach for the M-K-T—delivered weight 130,600 lb

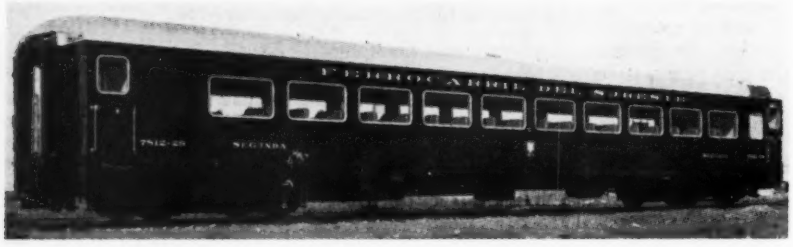

Fig. 43 German-built passenger car to American railroad standards for National Railways of Mexico

2 The continued development of features or components of cars to provide more reliable car service and better protection of the lading en route.

Rail-Trailer Operation. No treatise on the subject of railroad equipment would be complete without a reference to so-called "piggy-back" or rail-trailer operation. During the past year a large number of new and additional rail-trailer services have been instituted. In practically all instances conventional, one-level, normal-floor-height flat cars have been remodeled by the addition of drop gates in the ends, side guard rails and the necessary jacks, blocking and tie-down attachments to carry one or two trailers per flatcar. Considerable study has been given by both the railroads and the builders to special types of cars to permit end loading or side loading, or both, as well as special anchorage devices, for the trailers. Portable ramps have been devised for end-loading the trailers. It is anticipated that the next year will witness accelerated development and usage of the rail trailer.

Special Types of Cars. Of the special types of freight cars that have been built in the past year the following are examples of some of the unusual:

Two specially designed and constructed tank cars, each capable of transporting 100,000 lb of warm liquid chocolate, were recently put into service by the Walter Baker Chocolate and Cocoa Division of General Foods Corporation. The cars, built at the Sharon, Pa., plant

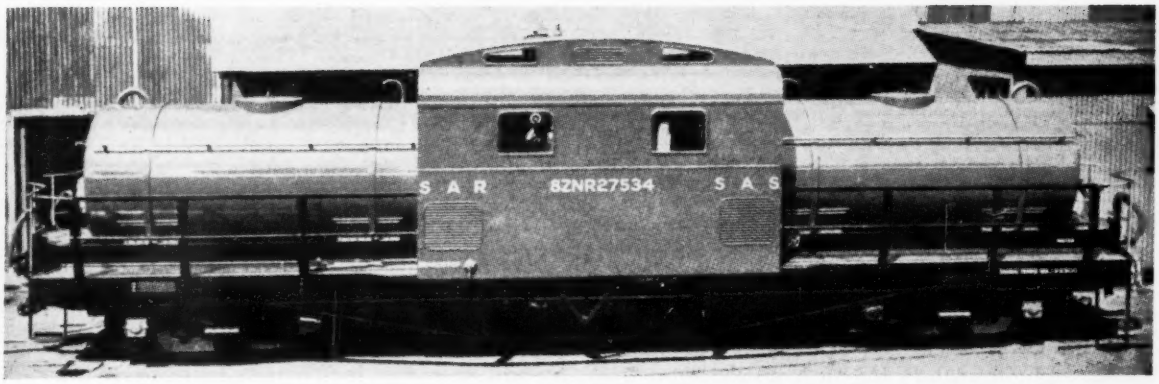

Fig. 44 Passenger-car heating tender for South African Railways for service with electric locomotive

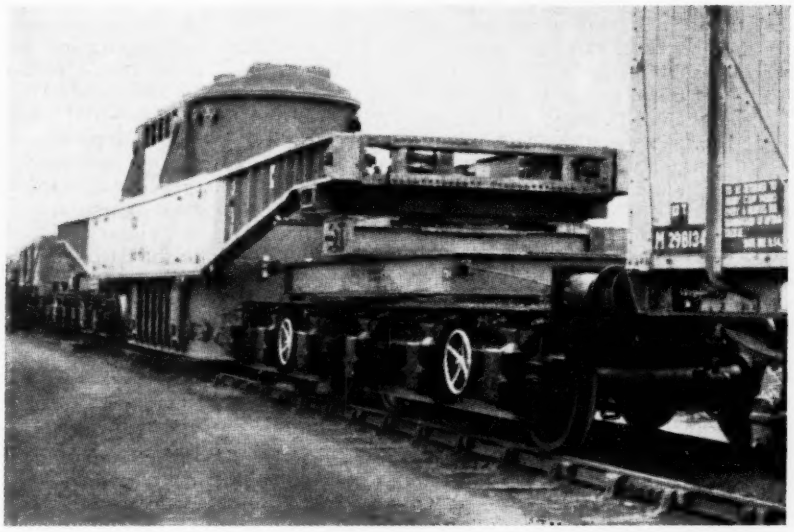

Fig. 45 Unusual type of transformer well car for British Railways

of General American Transportation Corporation, are regular-type tanks enclosed without outer water jackets. At unloading and loading points, hot water is circulated through the jackets heating the chocolate, thus speeding the loading and unloading.

Mathieson Chemical Company had 20 dry-ice cars built by the Fruit Growers' Express. These cars are for the shipment of packaged dry ice and are essentially refrigerated cars except that no ice bunkers or other means of cooling are required. The main new feature of these cars is an inner and an outer side door. The inner side door is insulated with the same thickness of insulation as used in the body. The outer side door is of the Youngstown sliding type.

The New York Central is service-testing six $53\frac{1}{4}$-ft flat cars equipped with a new design of Evans six-car auto loader. This loading device carries three autos on the raised or top deck. The cars are driven one at a time on a power elevating ramp, which, after three cars have been loaded, folds out of the way, leaving space for three additional automobiles on the lower level. Four cars normally were carried in the closed automobile car.

The Northwestern remodeled twelve boxcars in its own shops to handle wet wood pulp and prevent the pulp from freezing by insulating existing 40-ft steel-underframe composite boxcars. They have 193 cu ft greater capacity than the replaced refrigerator cars. In the rebuilding, the inside walls and ceiling were given a protective coating of car cement and then a framework was applied on the sides, ends, and roof to support the insulation. The insulation was covered with two layers of Sisalkraft paper over which plastic-faced plywood, having high abrasion and moisture resistance, was installed. The original flooring was covered with two layers of Sisalkraft paper and $\frac{7}{8}$-in. wood flooring.

High-Capacity Flat Cars. High-capacity flat cars are still in demand for special shipments of heavy bulky assemblies. The Pennsylvania built two additional high-capacity flat cars, increasing their fleet of these so called "super" cars to 325. These two additional cars, identified as F-38, have a lightweight of 165,500 lb, a nominal capacity of 500,000 lb, and a load limit of 587,500 lb. Two six-wheel trucks with $6\frac{1}{2}$-in. × 12-in. journals, the trucks on 15-ft centers, are used at each end of the car. These trucks carry a platform which has the

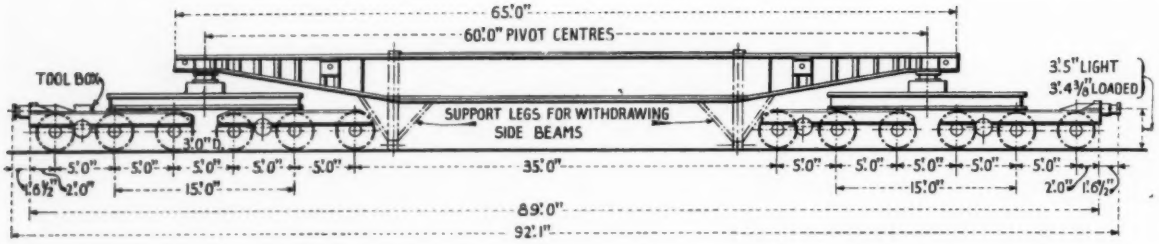

Fig. 46 General arrangement and dimensions of transformer car shown in Fig. 45, with side-traverse mechanism

coupler and draft gear at one end and in turn supports the main platform which is 50 ft long, and has a level floor 49¾ in. above the rail. The length of the strikers is 57 ft-11½ in.

The Santa Fe built in its Topeka shops a depressed-center flatcar having a capacity of 250,000 lb. The car has six-wheel cast-steel trucks with Timken roller bearings and 6½-in. × 12-in. journals. It has a cast-steel underframe and 3-in. decking on the upper levels. The weight is 125,500 lb and the car is 57 ft 9 in. long and 8 ft 0 in. wide at the decking.

An unusual design of well car, for carrying transformers, in use on the British Railways, is shown in Figs. 45 and 46. Lightweight of the car is 162,400 lb with a carrying capacity of 300,000 lb. The loading space is 31 ft in length, and from 6 ft 11 in. to 9 ft in width between the side beams on which the load is supported. A novel feature of the construction is the provision of a side-traversing mechanism which gives a maximum side traverse of 1 ft on either side of the center line to permit the clearance of side-of-track obstructions, when the load carried is wider than the normal loading gage.

Boxcars. Evidence of the continued study that is being given to reduction in lading-damages service is again emphasized by the 40-ft boxcar recently converted by the Frisco into an open-sided car to permit demonstrations to shippers, employees, and civic officials, and to emphasize to these people how the Frisco is developing and complying with the best possible procedures in handling of shipments which are entrusted to it.

Pullman-Standard built during this year one hundred 40-ft boxcars with a new-design cushion underframe designed to give additional protection to lading against damage in switching impacts and longitudinal road forces. This cushion underframe utilizes standard couplers, yokes, and draft gears, conventionally mounted in a center sill which is movable longitudinally with respect to the car body and incorporates at the center of the car a long-travel high-capacity cushioning device imposed between the center sill and the body. The combined draft gear and the cushion device have a capacity over four times that of a conventional draft gear. These cars are now in assigned experimental service on seven different railroads to determine their effectiveness in reduction of lading damage and protection of the car structure against switching impacts and train-operation shocks.

Roller-Bearing Installations. A greatly increased number of roller-bearing installations have been made in the past year. These were mostly on high-capacity cars retained in the owners' lines. Extensive studies and experiments are still under way in improving friction-type bearings, their lubrication and maintenance practices, with the expectation of reducing the hotbox problem materially.

Special German Cars. A number of new types of freight cars were also on display at the Munich, Germany, Communication and Transportation Exhibit. One of these was a four-axle, open, double-deck automobile carrier, capable of transporting ten automobiles; these cars are of the high-side, drop-end, gondola type. A second type was a four-axle, all-steel boxcar with a sliding roof permitting loading and unloading with a crane. A third type of car was a flatcar with rails running across the car which are used to guide 5-ton containers equipped with wheels from a transport truck to the flatcar. These three types of cars, while smaller than used in this country, are particularly interesting in view of some of the thinking and trends in the United States.

Acknowledgments

The Committee on Survey acknowledges with deep appreciation the assistance in procuring material for the report given by the railway press of the United States; the *Railway Gazette* and *Diesel Railway Traction* of London, England, and by the railways, locomotive and car builders of the United States, England, France, Germany, Sweden, Finland, Australia, New Zealand, and Switzerland.

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How to Select Consulting Engineers for Work Abroad

By W. Rogers Herod

President, International General Electric Company, New York, N. Y. Associate Member ASME

With the United States today occupying the position of world leadership, a wide field of opportunity and likewise a challenge are presented to American engineers abroad, particularly consulting engineers. To work effectively abroad, the consultant must be not only technically competent but well advised in foreign relations, economics, and political situations. In effect, he must be an "ambassador," creating respect and good will for things American.

Of the current world production, the United States with some 7 per cent of the world's population but with the world's most extensive industrial establishment, and using over 40 per cent of the world's animate and inanimate energy devoted to productive purposes, is currently producing some 40 odd per cent of the world's industrial and manufacturing output, with a correspondingly high consumption level. In these developments—thanks to good fortune, enterprise, science, and engineering—postwar world leadership has accrued to the United States. Currently, no other major nation approaches the United States in aggregate energy use, industry, or in power.

Opportunities Abroad

With this tremendous advantage in material progress, the United States has responsibilities toward the less fortunate nations of the world. Engineering leadership when coupled with resources historically has been accompanied by high living levels and power. Currently, this applies for America—and as this becomes more widely recognized, there is greater appreciation and demand for the American engineer's services.

During the war and early postwar period of free-world dependence upon the United States, American products, aid, loans, techniques, and ideas were widely spread abroad. This was due in part to their merit and to American enterprise, but also to the availability of American resources, goods, and services, while those of others were lacking or in short supply. Hence new fields were opened, and American products and engineers went abroad on an extended scale, meeting foreign situations and foreign engineering practice. Now with increased foreign availabilities, our products and consulting engineers are coming up against competition.

The American consulting engineer's own profit and greatest opportunity abroad are generally connected with projects involving American finance or equipment, or American techniques. As these increase or decrease, so does his opportunity. But abroad he meets alternative ideas, practices, products, techniques, and different backgrounds, economies, and labor conditions. He has found that the economic solution to an engineering problem abroad may be different from that at home. Hence our consulting engineers have acquired experience of a wider and more diversified type. While the flow of ideas and techniques probably has been more "outward" than "inward," there likewise has been a certain "value received" which will enrich the profession and increase its ability to deal with new situations at home and abroad.

Wide Range of Foreign Projects

Today one finds abroad American interest in investment, techniques, and equipment for oil drilling and refining, mining, blast furnaces, steel mills, locomotives, power plants, chemical and fertilizer plants, all kinds of factories, and in port and harbor facilities. These projects frequently lead our consulting engineers beyond the realm of purely technical consultation into those of contracting, construction, or operation. And in foreign practice, "single-responsibility" or "turn-key" projects are not uncommon.

The European engineering industry and sometimes the British, have staffed their organizations, created syndicates, and offered single tenders on a turn-key basis. Such turn-key jobs, for example in the power field, may involve everything except perhaps the purchase of the site; in other words, the specification of equipment, layout of the plant, construction, contracting, placing in operation, and initial tests; the completed operating project is then turned over to the purchaser. This frequently has advantage from the customer's view in single undivided responsibility—a single contract. Against this there are naturally various disadvantages. Usually a major equipment supplier is the prime contractor.

With American economic assistance abroad and with American investments and foreign trade in such diversified forms, and with accelerated foreign activity, a field of considerable opportunity has been opened for American equipment and for American consulting engineers. Where dollar finance is important and where American

Contributed by the Committee on Professional Practice of Consulting Engineering and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of The American Society of Mechanical Engineers. (Condensed version of paper as presented.)

equipment and techniques are preferred, the American consulting engineer is both needed and desired. However, where other than American finance, equipment, and techniques are involved, his field is more limited, and he has difficult competition. When engaged abroad his advice is frequently sought in non-technical matters.

In whatever sphere they have operated, our consulting engineers have effected a minimization of over-all cost and investment, and the maximum saving in time and resources. An extremely important activity has been to create and maintain confidence in the opportunities, execution, and successful operation of worth-while undertakings which, without their favorable opinion, advice, and even direction, could never enjoy the confidence and credit to attract financial backing.

Defining the Requirements

With this opportunity, what about the selection of the consulting engineer? Whether he be an individual, a firm, or a corporation, and whether his client be a government, company, bank, or individual, user, or prime contractor, it is naturally first necessary to define the objective to be accomplished, such as the provision of a power plant or a transportation study. Frequently, the consulting engineer can assist both in noting opportunities for constructive projects, and likewise in bringing any particular objective into sharper definition. The consulting engineer's economic mission is then through advice and counsel to facilitate the realization of that objective within whatever limitations there may be, with the greatest success and over-all economy, taking into account costs, time, effort, investment, and relations.

The economic contribution of the consulting engineer who guides and advises on the project, is measurable primarily in terms of the over-all contribution of the project to economic values, against the over-all costs, investment, effort, and use of resources, including those of the consulting engineer himself.

The selection of consulting engineers becomes largely a matter of judgment; and the criteria (other than cost and scale of magnitude in dollars, people, time, and so on, applicable to the project) become primarily qualitative, with all the difficulties this implies. Likewise as to social values—the bringing to fruition of the over-all project, generally speaking, represents the consulting engineer's greatest immediate contribution to social and economic values. Hence the project must be regarded in its totality. Even here measurement studies leave much to be desired. One looks to the consulting engineer for the "know-how" in the given circumstances; and that being largely qualitative, it sometimes can be stated but is difficult to measure. But one also looks to the consulting engineer in international work to inspire confidence. Hence the factors determining his selection may be numerous.

Criteria for Selecting an Engineer

Noting the definition of consulting engineer and his responsibilities, and with due deference to differing circumstances under which he may be employed, criteria may be suggested to govern his selection for work abroad:

1 The consulting engineer must have a comprehensive understanding of, and devotion to, the accomplishment of the objective. This obviously is fundamental.

2 He must have competence based upon proved ability, broad experience, and special training in the technical field applicable to the project, such that his technical advice shall be of the highest quality and be directed toward the most economic attainment of the objective. Previous successful foreign experience is a definite advantage in connection with other work abroad.

3 His professional integrity must be of the highest.

4 He must be able to address himself to new situations with judgment and success; and be adaptable to new circumstances and to different economic, social, or other conditions which may be encountered; such that with soundness, determination but with tact, he can promote and maintain harmony and co-operation in pursuit of the objective.

The foregoing criteria are basic. Each is necessary to success and confidence in the project, particularly where banking or financial accommodations must be arranged.

5 The consulting engineer should have imagination and be able to recognize favorable opportunities, both within the specific project and collateral thereto.

6 The consulting engineer and his client should recognize the value of cordial working relations and mutual respect. This is essential to the successful and economic accomplishment of the specific project as well as possibly other projects.

The consulting-engineer's services are needed and desired in many fields. He is a leader in his profession with a time-honored background of contribution in both economic and social values. He enjoys a position of dignity in his community. Today, his opportunities for usefulness have been expanded into foreign lands, where he can assist in bringing many worthwhile projects to fruition both speedily and economically.

7 The consulting engineer also must have a sense of his responsibility as a citizen of his country, and a contributor to social values. In attitude and in conduct he must deserve and earn the respect and friendship of all parties with whom he and his work come in contact, and be a respected individual.

8 He must be economical in his expenditures for the project, operate with dispatch, and be clear-cut in his recommendations, advice, and counsel. At the same time he should not be unmindful that his mission is to attain the objective of the project with greatest over-all economy rather than the specific economy of the engineering service performed.

9 He must be alert and able to recognize the advantages and disadvantages in various engineering practices at home and abroad, particularly in relation to the different economies and social backgrounds of other nations, and bring the benefit of such perspicacity to his client and profession on foreign jobs and on work here in the United States.

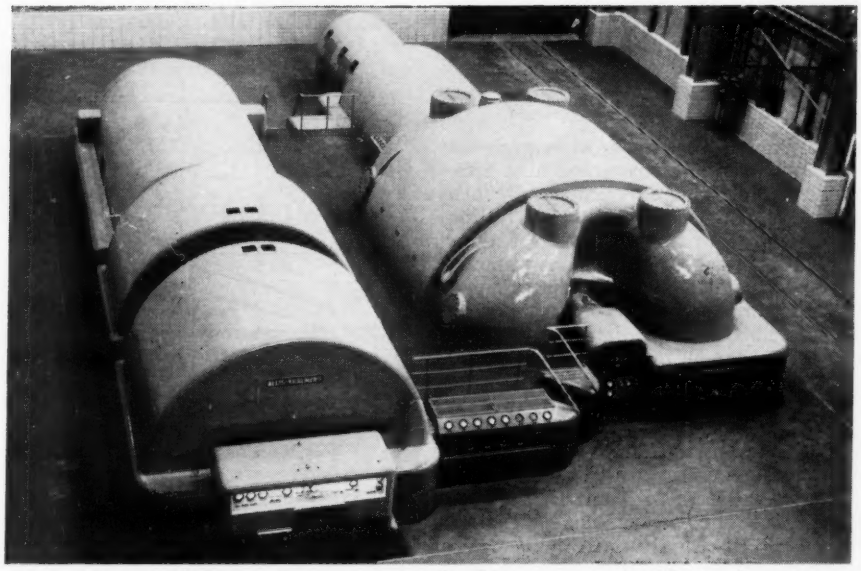

Fig. 1 Close-coupled type of cross-compound turbine-generator installation, first of three for the Oak Creek Station of the Wisconsin Electric Power Company

Large-Capability

Steam-Turbine-Generator Units

. . . made possible by compact close-coupled cross-compound arrangement

By C. D. Wilson

Engineer in Charge, Steam Turbine Design,
Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Member ASME

THE characteristics of the cross-compound steam turbine make it ideally suited for efficient application to generating units of large capability. With the 1800-rpm low-pressure turbine, it is possible to provide the optimum size of exhaust blading that is required for the efficient performance of a large machine. The cross-compound arrangement with two generators makes it possible to use moderate-sized generators on units of very large capability. For these reasons, the cross-compound machine becomes more and more attractive with increase in unit capability and also with decrease of exhaust pressure. When the exhaust pressure is 1 in. Hg or less, the cross-compound unit is attractive for ratings of 150 mw and larger. When the exhaust pressure is $1^1/_2$ in. Hg or less, the cross-compound unit can be applied efficiently for ratings of 200 mw and larger. At the present state of development of the 3600-rpm low-pressure-exhaust blade, the cross-compound design will be required, with few exceptions, for all units of 300 mw capability and larger.

Fig. 1 shows the first installation of this type machine, which was made at the Oak Creek Station of the Wisconsin Electric Power Company.

Contributed by the Power Division and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed slightly from ASME Paper No. 54—A-182.

Economic Considerations

The principal objections that have been raised in the past against the application of cross-compound turbine-generator units have been the higher initial investment, the anticipated complication of rolling and starting the two turbine-generator elements in parallel, and the increased floor-space requirements with the added expense of separate foundations for the high and low-speed elements.

Cross-compound steam-turbine-generator units in sizes where they are competitive with tandem-compound units

generally will require 6 to 20 per cent higher initial investment and the difference will vary with the size of the unit. Since the cross-compound machine will have better performance, the difference in over-all cost must be evaluated to determine the best machine for each application.

Many cross-compound units are now in service, including numerous modern, high-temperature, high-pressure reheat machines. Operating experience with such cross-compound machines has indicated that the rolling and starting in synchronism of the two turbine-generator elements presents no unusual or particularly difficult problems. The cross-compound turbine-generator is handled in the same manner as a single-shaft unit after the two generators have been synchronized by energizing the fields before starting or at turning-gear speed.

The floor-space requirement for the usual type of cross-compound machine has been greatly reduced by the new close-coupled cross-compound arrangement where both the high and low-speed elements are mounted close together on a common foundation. Any cross-compound design greatly reduces the over-all length when compared to the corresponding tandem-compound machine of the same capability. By locating the two machines of the cross-compound unit close together on a common foundation, the resulting unit width also is reduced. Either transverse or longitudinal installation of the turbines can be made with minimum crane span. A short and direct crossover pipe with pressure-balancing expansion joints has made the close-coupled design possible.

Performance

Figs. 2 and 3 indicate the relative performance at capability load of turbine-generator units larger than 150 mw which have various arrangements of 1800 and 3600-rpm low-pressure-exhaust turbine blades. For purposes of comparison, these curves show data based on initial steam conditions of 1800 psig and 1050 F with reheat to 1000 F. The curves illustrate the gains or losses in performance for various types of low-pressure-turbine elements. These are shown relative to a 3600-rpm tandem-compound triple-flow exhaust unit using the 26-in. exhaust blade, the longest blade now available for that speed.

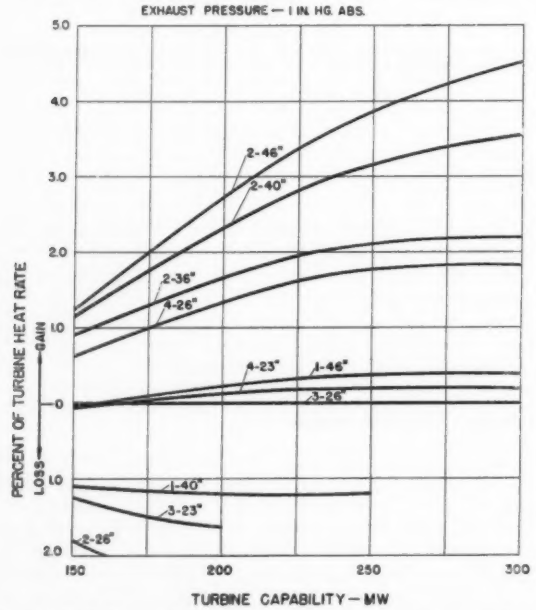

Fig. 2 Relative performance of large tandem-compound and cross-compound turbine-generator units for operation with 1-in-Hg abs exhaust pressure

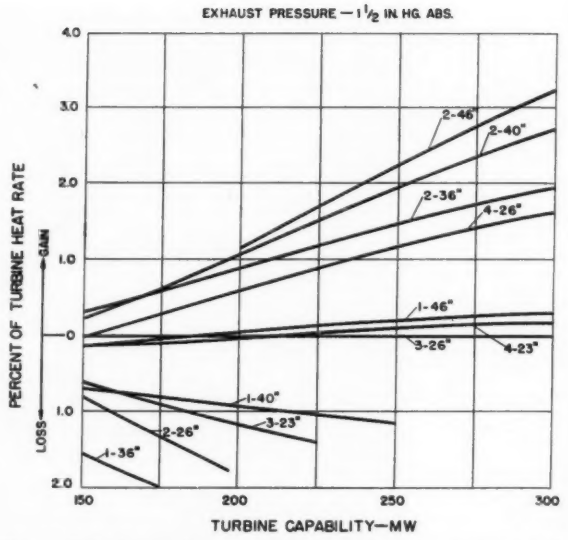

Fig. 3 Relative performance of large tandem-compound and cross-compound turbine-generator units for operation with 1 1/2-in-Hg abs exhaust pressure

Fig. 2 indicates the improvement in thermal performance that can be obtained at 1 in. Hg exhaust pressure when cross-compound units are used. The curves show that the per cent improvement over 3600-rpm tandem units increases with increase in unit capability.

For the 1-in-Hg exhaust pressure, the better performance of the cross-compound machine usually will justify its application for units of 150 mw capability and larger.

Fig. 3 is a similar family of curves showing the relative performance of the same range of unit sizes for 1 1/2-in-Hg exhaust pressure. For operation with this higher exhaust pressure, the better performance of the cross-compound machine usually will justify its application for units of 200 mw capability and larger.

Many of the cross-compound turbines now in service have been built with a 3600-rpm high-pressure turbine exhausting to a reheat boiler, the reheated steam returning to a tandem-compound 1800-rpm turbine. With this design, the excessive overspeed which might be caused by release of the potential energy in the large quantity of steam stored in the reheat section of the boiler and in the piping connecting the two turbines is effectively prevented by the reheat control valves.

It is more economical, however, to build as much of the turbine as possible in the high-speed element, and the smaller physical dimensions of the high-speed-turbine elements are better suited for operation with high steam temperature. With trends toward still higher steam temperatures, it becomes even more desirable to locate, on the high-speed shaft, the component of the turbine using the high-temperature reheat steam.

When this is done, the problem of controlling the volume of steam stored in the piping between the high and low-speed turbines must be considered. Fig. 4 shows the per cent increase in speed resulting from the

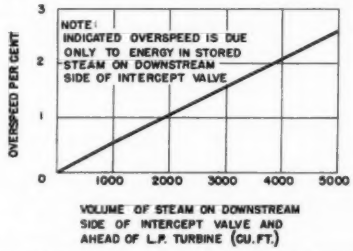

Fig. 4 Curve showing overspeed of typical large 1800-rpm turbine due to volume of steam trapped between intercept valve and low-pressure turbine

energy in the steam stored in the intermediate-pressure turbine and large crossover pipe between the intermediate and low-pressure turbines. The values plotted on this curve are calculated for a typical cross-compound unit on the basis that governor inlet valves and reheat intercepting valves are fully closed.

The first close-coupled cross-compound turbine-generator unit was placed in service in 1953, Fig. 1. A duplicate machine of this type was placed in service in 1954, and a third will be installed in 1955. Each of these three units is rated at 120 mw, and all are located in the Oak Creek Station of the Wisconsin Electric Power Company. The cross-compound design was used for these relatively small ratings because, with the availability of cold Lake Michigan circulating water, the turbines were designed for $^1/_2$ in-Hg-abs exhaust pressure. Therefore the large exhaust normally used on units of more than twice the capability was necessary.

A cross section of the high and intermediate-pressure turbines is shown in Fig. 5. These turbines are arranged with steam flows opposed and with the pivoted-pad thrust bearing located between the turbines to minimize differential expansion between stationary and moving parts. The low-pressure-turbine cross section, Fig. 6, shows the double-flow low-pressure turbine with 40-in. blades in the last moving rows.

Machines of Large Capability

The close-coupled, cross-compound design can be applied to very large capability machines. As the capability of the turbine is increased, it is desirable to build more of the heat drop into the double-flow low-pressure turbine so as to maintain acceptable stress levels in the single-flow 3600-rpm blading. This results in a change in the load split between high-speed and low-speed elements with a decreasing percentage of the load being carried on the high-speed shaft when the turbine capability is increased.

The load split between high and low-speed elements varies from about 60 to 40 per cent, respectively, on the smaller machines and about 50 to 50 per cent on the larger units.

In the case of a close-coupled cross-compound design for a 325-mw machine, suitable for $1^1/_2$ in-Hg-abs exhaust pressure, the load division results in a 180-mw generator on the high-speed element and a 145-mw generator on the low-speed element.

In this machine, the high and intermediate-pressure 3600-rpm turbines have the common thrust bearing and the anchor point of the high-speed element located between the two components. The side crossover pipe to the low-speed turbine also is located close to the high-speed thrust bearing to obtain minimum over-all unit length and also to minimize the axial-expansion displacements that have to be provided for by the crossover expansion joints.

The low-pressure element consists of two separate opposed-flow turbines with a journal bearing between and with the steam inlets located on either side of this

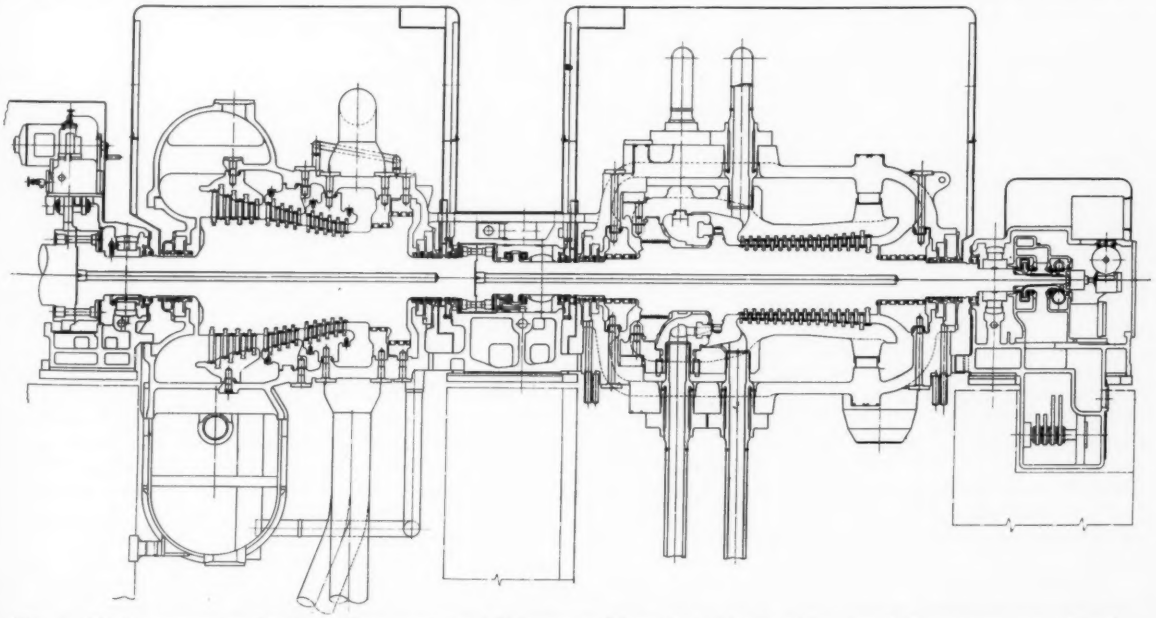

Fig. 5 High-pressure and intermediate-pressure 3600-rpm turbines for 120-mw close-coupled, cross-compound unit

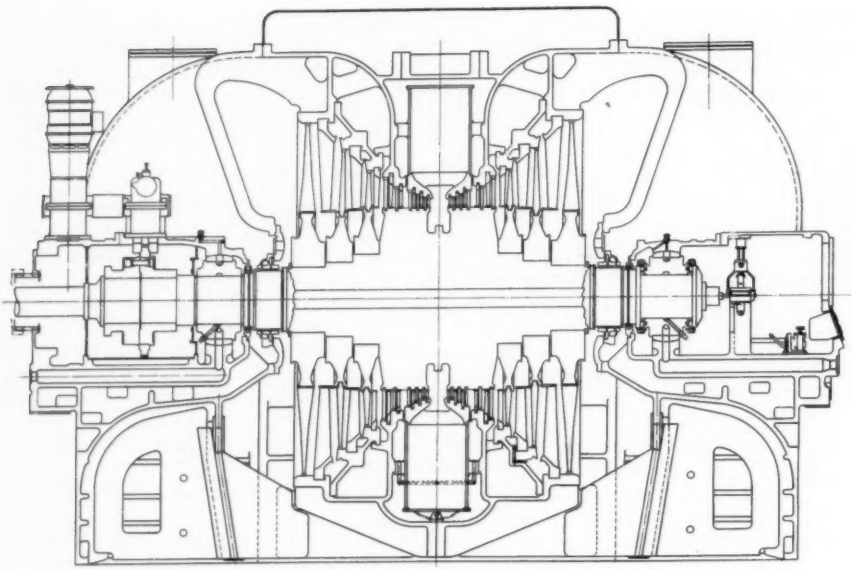

Fig. 6 Low-pressure 1800-rpm turbine with 40-in. exhaust blades for 120-mw close-coupled, cross-compound unit

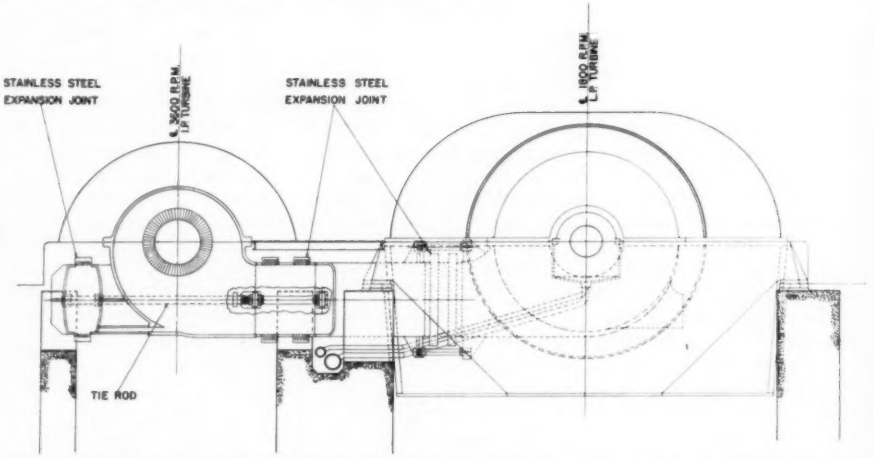

Fig. 7 Transverse section through 325-mw close-coupled, cross-compound turbine-generator unit, showing arrangement of crossover pipe, oil-pipe manifolds, and design of foundations

center bearing. This construction, with three bearings for the low-pressure turbine, results in a short and rigid shaft system. Each half of the low-pressure spindle and casing cover can be lifted separately, which simplifies maintenance operations.

The location of the two steam inlets close together at the center makes possible the building of a short and direct crossover pipe, Fig. 7, that has the minimum volume of stored steam as well as the minimum pressure drop.

The expansion joints shown in Fig. 7 are of stainless steel and are protected against mechanical damage by stainless-steel shields. Expansion joints are located on either side of the 3600-rpm intermediate-pressure turbine and tied together by external pivoted links to balance the thrust forces resulting from internal steam pressure.

Smaller stainless-steel expansion joints in each of the two branch inlets to the low-speed turbines have the tie links across the expansion elements to resist pressure forces.

Other inherent advantages of the close-coupled, cross-compound arrangement shown in Fig. 7 include single oil-feed and drain manifolds to supply oil to and from the bearings on both shaft systems. The oil manifolds are located in a trench in the foundation between the two units and are thereby shielded from the high-temperature turbine parts. This design also makes it possible to provide solid wall supports below the heavy low-pressure turbine. With the condenser mounted longitudinally, space for tube withdrawal can be provided in front of the low-speed element. Low-pressure extraction lines and crossover pipes are all external to the condenser so that the turbine-exhaust trunk and condenser neck can be designed with minimum internal obstructions.

Machines With a Future

In recent years there has been a rapid growth of the electric-power-generating capacity of the public utilities, with an inevitable demand for generating units of larger and larger capability. The accumulation of design and operating experience points to the cross-compound steam turbine as best suited to meet the requirements of the larger-capability units that will be increasingly needed. The inherent advantages of the close-coupled, cross-compound arrangement make it ideal for such applications.

Trends in Global Air Logistics

Air-lift potential increases both with engine and transport developments

By Donald W. Douglas, Jr.

Vice-President—Military Relations,
Douglas Aircraft Company, Inc., Santa Monica, Calif.

Today's logistics problems call not only for primary policy decisions regarding types of aircraft but, in addition, loading and handling methods, packaging for air, and terminal facilities. Technological developments in aircraft and engines provide the basis for creating a modern logistics system, which will strengthen the American economic and defense position.

ALL military leaders know that strategy, logistics, and tactics are closely interwoven in these days of high-speed and high mass warfare. Although strategy may call the shots, the number of shots that can be called at any time or in any place will often be determined by logistics. Although grand tactics may decide how the battle will be fought, the supplies for the battle depend on the available system of logistics. Logistics governs the extent to which strategy can be carried out and how much tactics can use.

One of the most important factors in logistics today is the simple, undeniable fact that modern air transports travel farther and faster than earlier models. This means that as the speed of our defense-support weapons—our transportation system—increases, we require fewer fixed bases or units to extinguish international "brush fires." If the time in transit for men and supplies can be counted in hours instead of days, obviously, we will require fewer centers of operation.

Air Transport Cuts Stock Piling

Consider the problem of supplying spare engines and other reparable equipment to units stationed in Korea and in North Africa. While our military services are trying to reduce the engine-replacement rate by every means possible, nevertheless, to maintain a state of combat readiness, training missions must be continued, and this makes it necessary to establish a replacement system.

Contributed by the Aviation Division and presented at a joint session of the Aviation and Materials Handling Divisions, Institute of Aeronautical Sciences, Society of Automotive Engineers, National Security Industrial Association and Transport Air Group, and presented at the Annual Meeting, New York, N. Y., November 29-December 8, 1954, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from ASME Paper 54—A-267.

Let us assume that the time period in transit and repair is nine months. By a conservative estimate, time could be reduced by one third if the components were transported by air.

This reduction is equivalent to a three months' supply of engines and equipment, the cost of which would be more than the cost of air transportation. Furthermore, the flexibility of air transport eliminates the necessity of expensive stock piles of idle equipment in various theaters of operation.

If the entire military expenditure for supplies and materials is considered in the light of shortened and faster pipe lines, we see that savings of billions are possible without reducing military effectiveness.

Transport Requirements

In outlining the optimum performance of an aircraft, three major elements involved in arriving at a transport-aircraft design become apparent, namely, its pay load, its range, and its speed. Each of these must be compromised to a certain extent in order to improve the remaining two. But the more we can increase any one of the factors without cutting down on the other two, the more work an airplane can do in a given period of time.

We may ask ourselves: "What limits the pay load, speed, and range?" The answer has always been the available power plants. Engine weight reduces the amount of pay load (or the amount of fuel) that can be carried—and thus the range. We have seen a gradual, but constant, improvement in the weight-power ratio of reciprocating engines. However, we are approaching the limit of development, which thus far has limited the size and efficiency of cargo transports.

The Turboprop Engine

In the turboprop engine, we have a dramatic improvement in power resulting from current development of the gas-turbine engine. One outstanding application of the gas turbine is the turboprop combination, which we feel has the most desirable characteristics for a cargo-carrying airplane.

The turboprop delivers a large amount of power in relation to its weight and fuel consumption and thus can carry a heavy pay load. With the turboprop we come out very well in the inevitable compromise of pay load, speed, and range.

Currently, we have a power plant known as the T-34, which produces 5700 hp. On February 2, 1954, at Long

Beach, we flew the YC-124B—an adaptation of the familiar Globemaster—powered by four of these T-34 engines. Eventually, these engines will be installed in the first of a new series of transports of larger size than the C-124. For the present, we will continue to fly the YC-124B to gain experience with the new type of power and to eliminate the "bugs," which are characteristic of any new mechanical device.

The new transports will incorporate in satisfactory measure the critical elements of pay load, speed, and range, all of which have been increasing substantially.

Increased Air-Lift Capacity

Studies show that as air-lift capacity rises, the operating costs per ton nautical mile go down. As operating costs go down, items of lower monetary value become logical candidates for air lift. The new transports being developed and built promise ton-mile operating costs of from one half to one quarter those prevailing today in airplanes such as the C-124, which is already considerably better and more efficient than the C-54.

As air-lift capacity grows, and more items can be carried at air-transport speeds, smaller quantities of material need to be stock-piled at bases abroad. Thus the expense and political complications of many bases and personnel can be reduced. More of our military power can be based in the continental United States, and still be available to meet emergencies quickly throughout the world.

The advent of these new aircraft may well cause us to be less vulnerable. We may be able to reduce the attention we pay to protection of the sea lanes, which protection appears more and more difficult in the light of expected enemy capabilities. We probably will be forced to concentrate more on the protection of our overseas air lanes, perhaps an easier task.

Within the next decade it does not appear possible to place complete dependence on air logistics to the exclusion of surface logistics, even for military purposes. Although it is conceivable that food and subsistence supplies, possibly even ammunition, might be logically air-lifted, it does not seem likely that fuel can consistently be supplied and moved by air.

Subsequent to the next decade we might possibly see fuel requirements diminishing. The nuclear power that is being applied to some of our naval vessels now may be the mainspring that makes possible the air-logistics transport of practically all military elements of power.

Wider and wider spread of the use of nuclear power conceivably can release us eventually from the necessity of transporting the chemical fuel supplies that have become such a millstone around the neck of military logistics.

There will be those who say this cannot be done. But if the technical advances of the next few decades are on a par with those of the last few, it will be done.

Varied Transport Requirements

Even before the arrival of the atomic-powered craft, the ultimate utilization of the turbine engine will produce vehicles of long ranges, high speeds, and large carrying capacities.

But I want to make it clear that a complete logistic system will not only require these great carriers but other categories of airplanes as well. The fundamental nature of the airplane fits into this pattern of varied transport requirements. It happens that the best compromise of pay load, speed, and range, is found at a different point on each size or category of transport. There is no common denominator for every task everywhere.

The pattern of different pay loads and ranges goes hand in hand with any system of distribution and collection. The very nature of our economy that produces goods for peace, as well as for war, calls for widely separated centers of production throughout the country. Such geographical separation calls for collection at central points of the supplies before they can be taken on the long hauls between continents, to be distributed among our many bases or areas of distribution in foreign lands.

It is evident that no single airplane can do every transportation job. We need airplanes with the greatest possible ton-knot productivity for mass movement of material over long ranges which we, at Douglas, believe should be turboprop. Use of such transport planes will reduce materially the quantity of supplies in surface pipe lines, in depots, and ammunition dumps.

Another requirement is minimum cargo and the rapid deployment of our SAC forces. This we, at Douglas, would necessarily recognize as the job for the speedy jet. It provides the speed and necessary carrying capacity to fulfill the mission.

In addition to performing the SAC deployment mission, these high-speed jet transports afford excellent opportunity in effecting the personnel pipe line. There also will be those inevitable bottlenecks that are created by unforeseen situations that will require high-speed jets. The quick supply of plasma, a small but critical replacement part, litter patients from the battle zone, where the cost is not important, will be solved by the quickest means now known—the jet.

In addition to high-speed jet and long-range requirements, there is the need for distribution and collection of material on either end of long hauls.

Finally, the complete supply chain would require serious study of a vertical-capability transport which will be able to operate into forward areas where landing and take-off facilities must be extremely limited.

All these varying types of aircraft, or family of aircraft, are needed to utilize fully the advantages of air transportation. It is the development of a system that will pay the real dividends.

Air-Logistics Policy

We cannot and should not expect to have the system of air logistics by a sudden appearance of these large transports. It will take time before we can place the huge potential to work profitably. It is the use of the present-day aircraft that will make the transition possible. Further, we cannot let our aircraft sit on the ground with low utilization and expect cost per ton-mile that will reduce the total military expenditures by using air. Some reserve is necessary, but only by a fleet-in-being and daily flying will the services be able to perform the total air-lift requirements during time of emergency.

The speed of the present-day activities on the battle front requires that we be ready at all times and yet use the tools that are provided profitably during so-called peacetime.

Water-Lubricated-Bearing Development Program...

. . . on journal and thrust bearings finds that very hard materials including ceramics, tungsten carbides, and some stellites perform well when loads are kept within limits recommended for water service. Select grades of carbon-graphite perform well with some metals and ceramics and, in one test, a ceramic-to-ceramic combination operated successfully.

By William M. Wepfer[1] and Eugene J. Cattabiani[2]

FROM the onset of the Atomic Energy Commission's reactor-development program many novel problems have presented themselves. One, though not strictly new, is that of water-lubricated journal and thrust bearings.

All water-cooled reactors must have large quantities of water circulated through them. Leakage tolerances of radioactive water from the primary loops are usually extremely small, often dictating the use of hermetically sealed pumps. The necessity for water lubrication is one price which is paid in these sealed pumps because the bearings must be lubricated by the fluid being pumped.

Probably the greatest drawback to the use of water as a lubricant is its low viscosity. Fig. 1 shows a comparison in load-carrying capacity between water and oil-lubricated bearings of the same size. Generally, it can be said that a water-lubricated bearing will carry a safe load of one-tenth that of an oil-lubricated bearing. As with most liquids, the viscosity diminishes with increasing temperature, reducing further the load-carrying ability of the bearing. Also, water promotes the static and contact corrosion of bearing surfaces, particularly during periods of shutdown when often relatively large quantities of iron oxide are built up. It is fortunate that this material is composed of extremely fine particles and will flush away during operation.

Most applications of water-lubricated bearings use carbon-graphite as one of the bearing elements. Carbon-graphite is wetted readily by water, is compatible with many metals, can be formed readily, is available in wide ranges of hardness, will take a high surface finish, will provide some measure of lubrication even if dry, and will, in many cases, assume the role of the wearing member in both normal operation and event of failure, thus protecting its mating material. Carbon-graphite materials are inherently brittle, and must be adequately mounted and supported. It has been said of oil-lubricated thrust bearings that the softer material should always be made the stationary or shoe element, so as not to subject the softer body to the alternating stress which the thrust runner experiences. With water-lubricated bearings, there is no observable difference when either rotating or stationary elements are made of the carbon-graphite.

In the design of reactor systems, extraordinary emphasis is placed upon reliability, because of the radioactive hazard associated with servicing of components. This, together with the questionable behavior of carbon-graphite materials under impact, prompted the establishment of an extensive water-lubricated-bearing development program.[3]

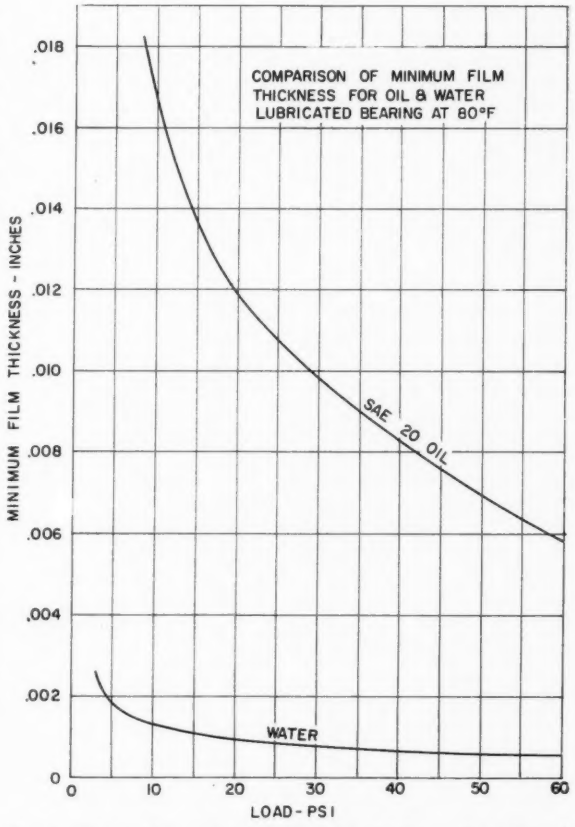

Fig. 1 Comparison of minimum film thickness for oil and water-lubricated bearing at 80 deg

The main purpose of the program was to investigate thoroughly all materials which were believed to have any merit whatever as bearing components. In general, the classes of materials which were given consideration

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[3] This program was sponsored jointly by the Atomic Energy Commission and the Navy Department in connection with the Submarine Thermal Reactor project, and was under the administration of the Westinghouse Electric Corporation.

were the following: carbon-graphites, graphalloys, stainless steels, bronzes, aluminums, stellites, colmonoys, hastelloys, carbides, ceramics, plastics, and plated and nitrided materials. Many of the materials were immediately ruled out because of low corrosion resistance.

Thrust-Bearing-Material Testing Equipment

For the development work on thrust-bearing-material combinations, three testing machines were built,[4] one of which is shown in Fig. 2. The design of the unit was such that the test bearing operated in a container of distilled water at 200 F and an ambient pressure of 40 psi. Although actual service applications called for 2000-psi system pressures, it was considered that for test purposes an ambient pressure great enough to prevent cavitation would suffice.

The machine was so designed that the flat-faced thrust runner was mounted and fixed to the main drive shaft with the bearing face downward. The runner was rested and rotated upon pivoted thrust shoes, 8 in. OD $\times$ 4$^1/_2$ in. ID mounted upon an equalizer system. The entire bearing was enclosed in a test chamber. Fig. 3 shows the upper part of the thrust unit with cover removed.

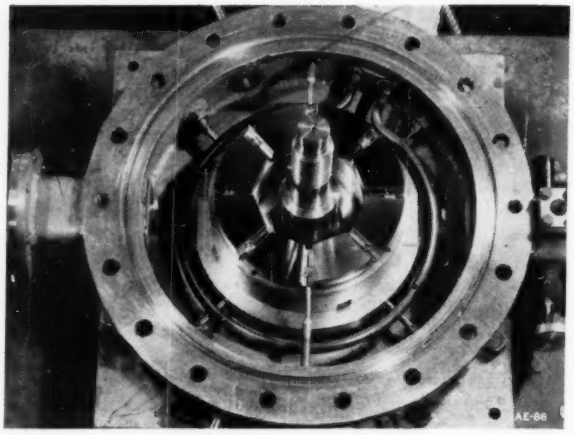

Fig. 3 Upper part of thrust unit with the cover removed

The centrally located drive shaft of the test machine was powered by two motors; a low-output-speed gear motor for high starting torque, and a high-speed motor for running at test speeds.

[4] This work was carried out by The Franklin Institute, Philadelphia, Pa.

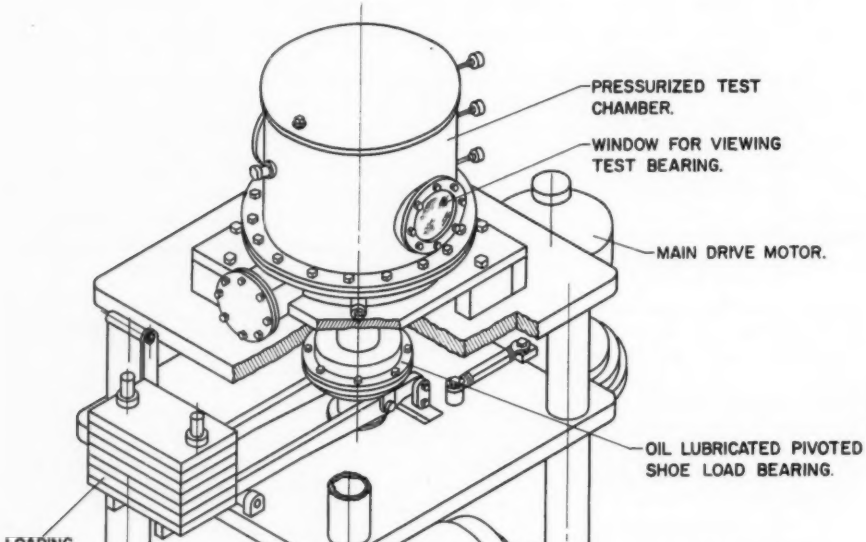

Fig. 2 Thrust-bearing testing machine. Test bearing operates in a container of distilled water at 200 F and an ambient pressure of 40 psi.

The thrust load was applied through an oil-lubricated double thrust bearing. A cam was provided against the load arm so that the load could be relieved or applied at a given rate.

Friction torque was measured by observing the amount of rotation of an elastically restrained disk which supported the bearing. The disk to which the bearing cage was secured was floated on four water-pressurized circular pads.

Fluid temperature within the housing was controlled by an electric heater and thermoswitch.

The fluid pressure within the housing was applied and controlled by means of a bladder-type accumulator and a constant-pressure nitrogen supply. The accumulator served as a replenisher for any leakage from the pressurized system.

The test machine was designed to impose thrust loads up to 1000 lb and shaft speeds of 900, 1800, 2700, and 3600 rpm. The auxiliary components of the machine were capable of oxygenating the water, and, maintaining it at a constant pressure up to 100 psig, and at a constant temperature up to 250 F. Running friction torque, water temperature, and pressure were all recorded continuously.

Thrust-Bearing Test Operation

In conducting a test it was found that much time could be saved by performing a "hand" test in a cold system. The main shaft was turned by the use of a handle attached to the motor pulley and a speed of 150 rpm could be attained. During this test the load was applied gradually, and it was found that the ability of the bearing to carry load at this low speed was often indicative of its future success at higher operating speeds.

Materials were tested where possible at 3600 rpm for a 200-hr continuous run in 200 F oxygenated water. Many materials, however, including especially the ceramics, operated with higher friction coefficients than anticipated and it was necessary to run these at 1800 rpm. If a material combination were successfully run for this period, a 500-cycle start-stop test was run, each cycle consisting of a 4-min operating period and a 1-min rest period to allow the residual lubricating film to squeeze out.

A listing of those material combinations which performed satisfactorily is shown in Table 1. For consistency, all load tests were run with a total load of 600 lb, equivalent to about 21 psi bearing pressure.

The data indicate that best results were experienced with the very hard materials. It is likely that this is true even when both bearing elements are of the same material, an unconventional concept where the prevalent cause of failure is galling.

Of interest in connection with the thrust-bearing tests was the work done on shoe-face contour. Results showed that a convex surface was definitely advantageous. It is probable that the chief advantage of the shoe crown lies in the more certain avoidance of developing a concave condition when at operating temperature. A concave shoe surface appears to destroy hydrodynamic film formation by preventing entrance of fluid at the shoe leading edge. It is interesting to speculate that most oil-lubricated thrust shoes, generally finished very flat, may actually acquire a crown by deflecting under load, whereas the much more lightly loaded water-lubricated shoes do not benefit from this effect.

Table 1 Thrust-Bearing Tests—Results on More Favorable Material Combinations

Bearing shoe	Thrust runner	Remarks
Stellite 3	Stellite Star J	Ran 200 hr, 500 start-stop cycles. Burnished, no wear.
Stellite 6	Tungsten carbide carboloy 55B	Ran 500 hr, 500 start-stop cycles. Burnished, no wear.
Stellite 6	Copper graphalloy	Ran 150 hr at 1800 rpm, 200 hr at 3600 rpm, 500 start stop cycles. Slight scratches on shoes.
Stellite 12	Silver graphalloy	Ran 200 hr, 500 start-stop cycles. Shoes slightly scratched.
Aluminum oxide, CP[a]	Tungsten carbide carboloy 55B	Ran 220 hr, 500 start-stop cycles. Shoes burnished, no wear.
Aluminum oxide, CP[a]	Aluminum oxide, CP[a]	Ran 140 hr at 3600 rpm, 1000 start-stop cycles. No wear.
Aluminum oxide, CP[a]	Bonded Aluminum oxide	Ran 318 hr, 500 start-stop cycles. No wear.

[a] Cold pressed.

NOTE: All tests at 21 psi load and 1800 rpm unless otherwise noted. Tested in high-purity oxygenated water at 200 F and 40 psi pressure.

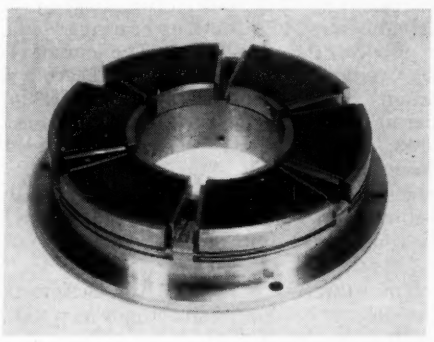

Fig. 4 Six-shoe 8 1/2-in-diam thrust bearing

The benefits of crowned thrust shoes have been observed and investigated by others.[5] Those used in the thrust tests described here were crowned to 25 light bands, or about 0.0003 in. Initially, the crown was applied after final lapping by rotating the shoe about its geometric center with the face downward, rubbing on fine abrasive paper. The higher rubbing velocity at the larger radii effected this crown. A later method consisted in heating the shoe in an oven to about 200 F and rubbing on a lapping plate. In contacting the cold plate, the shoe tends to warp, becoming slightly concave, and the rubbing thus removes material from the outer portions of the shoe face. When cool, the shoe has a convex contour. Thrust-bearing shoes in some water-lubricated pump bearings are now regularly provided with a crown.

A typical 8 1/2-in-diam thrust bearing is shown in Fig. 4. This is a six-shoe, fully equalized, and self-leveling

[5] "The Influence of Surface Profile on the Load Capacity of Thrust Bearing With Centrally Pivoted Pads," by A. A. Raimondi and J. Boyd, Trans. ASME, vol. 77, 1955, pp. 321–330.

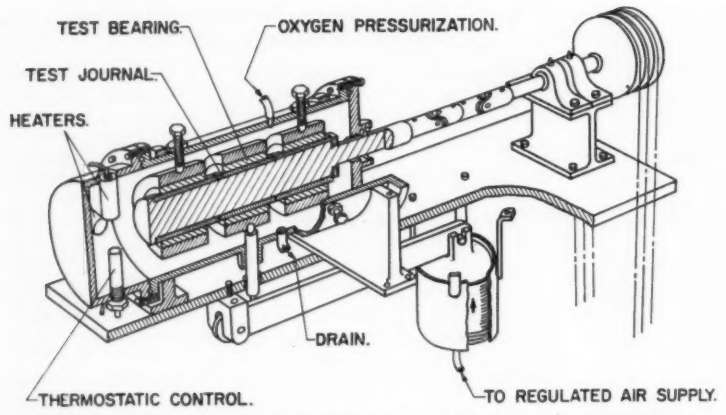

Fig. 5 Drawing of water-lubricated journal-bearing testing machine

pivoted-pad bearing. An equalized bearing is considered a necessity for water-lubricated service, where the fluid film thickness is small.

Journal-Bearing-Material Test Equipment

For the materials-investigation program with respect to journal bearings, three machines were built capable of testing $2^3/_4$-in-diam × $2^3/_4$-in-long bearings.[6] Fig. 5 is a drawing of one of these machines. The journal was supported on two main bearings; the center bearing was the test bearing. All three bearings were self-aligning; the main-bearing housings were positioned by three adjusting screws, while the test bearing was loaded by a hemispherical tipped pin.

Unidirectional loads were applied pneumatically by a metal bellows just beneath the base plate. Two units had a maximum load limit of 72 psi, and one unit had a limit of 720 psi.

The temperature was maintained by thermostatically controlled electric heaters. Start-stop tests could also be made on these machines.

The bearing testing sequence was as follows:

1 With the unit assembled and at 200 F, the journal was rotated at 3600 rpm, and a unidirectional load was applied at a rate of 25 psi per hr until 72 psi was reached. The test was continued for 24 hr at 72 psi.

2 As above, but at 1800 rpm.

3 As above, but at 900 rpm.

4 A stop-start test was run at 900 rpm and 25 psi. The cycle was 15 sec off and 45 sec on. The test continued for 1000 cycles.

Some preliminary testing was done on small $1^1/_4$-in-diam × 1-in-long bearing test units, and the information received from these proved helpful in selecting promising material combinations for tests in the larger machines.

A listing of the more favorable material combinations is given in Table 2. Of all the materials tested the ceramic materials appear to offer the most promise. These materials have been tested against tungsten-carbide and Stellite Star J with success. Their wear resistance, antiseizure characteristics, absence of material transfer, good shock resistance, and adequate corrosion resistance are attractive. In general, when bearing failure does occur with ceramics, the surfaces are not damaged appreciably, and the bearing is still operable at reduced loads.

Only one metallic bearing material, a silver-lead electroplate, gave excellent performance. Using a tungsten-carbide journal, after failure at 125 psi, the bearing was still operable at the normal load of 50 psi. No wear or corrosion was detectable.

The performance of Graphitar 14 bearings[7] using hardened 17-4 PH journals was good. This bearing material has a high load-carrying capacity and relatively low wear rate under stop-start conditions, and does not appear to be affected adversely by the presence of grit in the lubricant.

Table 2 $2^3/_4$-In-Diam Journal-Bearing Tests—Results of More Favorable Material Combinations

Bearing	Journal	Diametral clearance (cold)	Load, psi	Remarks
Boron carbide	Tungsten carbide Firthite H-13	0.0043	72	Tested 10 hr. No wear or corrosion. Journal polished
Boron carbide	Tungsten carbide Firthite T-66	0.003	72	Tested 44 hr. No failure
Aluminum oxide, CP[a]	Tungsten carbide Firthite T-66	0.003	72	Tested 72 hr. No failure
Boron carbide with titanium boride addition	Tungsten carbide Firthite T-66	0.003	72	Tested 72 hr No failure
Boron carbide	Stellite Star J	0.003	72	Tested 72 hr. No failure
Aluminum oxide, HP[b]	Stellite Star J	0.003	72, 25	Tested 72 hr. No failure. 600 start-stop cycles
Silver-lead	Tungsten carbide Firthite H-13	0.003	72–125	Tested 195 hr. 1410 start-stop cycles. Failed when loaded to 125 psi
Carbon graphite	Stainless steel 17-4 PH Malcomized	0.0035	75–175	Tested 196 hr. 4100 start-stop cycles. Loaded to failure at 175 psi
Boron carbide with titanium boride addition	Tungsten carbide Firthite H-13	0.003	72	Tested 301 hr. No wear. Bearing and journal highly polished
Aluminum oxide, CP[a]	Tungsten carbide Firthite H-13	0.003	72	Tested 78 hr. No failure
Aluminum oxide, HP[b]	Tungsten carbide Firthite H-13	0.003	72	Tested 101 hr. No failure

[a] Cold pressed.
[b] Hot pressed.

[6] The material given here is a condensation from the complete report on the subject, BMI 843, "The Performance of Water-Lubricated Sleeve Bearings," which is available for 35 cents from the Office of Technical Services, Department of Commerce, Washington 35, D. C.

[7] A product of the U. S. Graphite Company, Saginaw, Mich.

Another type of sleeve-bearing test apparatus that was used is shown in Fig. 6.[8] The test device consists essentially of a rotating shaft that is loaded radially by a flat spring through two load bearings at the center of the shaft. Since the test bearings are smaller in diameter they undergo a higher unit loading than the load bearings. The drive motor is canned and operates in the same water that is contained in the test chamber. This type of arrangement permits operation at high ambient pressures and at temperatures considerably in excess of 200 F if desired. The bearing test water is heated by tubular electric heaters that are wrapped around the test chamber.

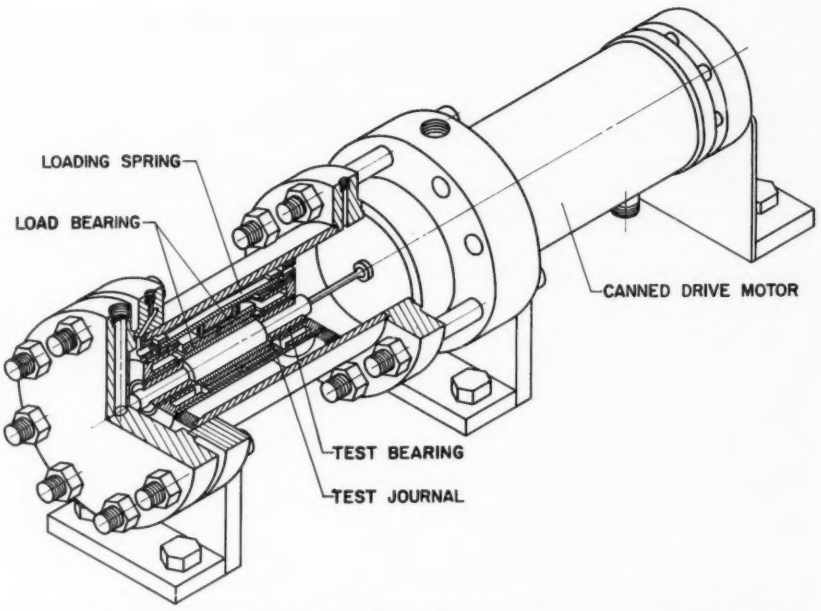

Fig. 6 Diagram of another type of water-lubricated sleeve-bearing test device

During the bearing tests, the following conditions are maintained in the test chamber: (1) Medium—water of very high purity and 6.5–7.5 pH; (2) ambient temperature, 200 F; (3) ambient pressure, 1500 psi; (4) speed, 3600 rpm constant; (5) oxygenated water.

The actual test and inspection procedure was designed so that each likely material combination could be evaluated from the standpoint of wear, resistance to corrosion, resistance to seizure and surface destruction, and load capacity. The loading schedule used was 200 hr of test at each of the following loads: 20, 40, 60, and 80 psi based on projected bearing area. An inspection of the bearings was made after every 100 hr of test. All of the material combinations tested underwent this loading series unless they failed before the test was completed.

During inspection, the following measurements and observations were made:

1 Journal and bearing diameters were measured with a precision air gage to detect wear. This instrument allows the bearings to be measured to the nearest 0.00001 in.

2 The average and maximum values of surface finish in microinches rms were measured with a profilometer on all bearing and journal surfaces.

3 Visual observations were made to detect any of the following: scoring, corrosion—static and contact, galling, and polishing.

The pertinent dimensions of the test bearings and the calculated film thickness, Sommerfeld number and coefficient of friction for the loading schedule are given in Table 3.

Because 800 hr of test time is needed to make each complete test with this procedure, only 40 material combinations were tested in two years of operation. The results of the tests on the nine combinations that showed the most promise are listed in Table 4.

Extensive testing was done in many bearing grades of

[8] This part of the development program was performed at the Westinghouse Atomic Power Division Laboratories.

Table 3

Diam, in.	1.502 to 1.5025
Length, in.	2.00
Diametral clearance, in.	0.002 to 0.0025
Diam/Cl	750 to 600
Length/diam	1.33

Load, psi	Min. film thickness $\times 10^{-3}$, in.	Coef. of friction $\times 10^{-3}$	Sommerfeld no. sec/min
20	0.78–0.81	2.26–0.71	4.51–2.88
40	0.56–0.45	1.4–0.57	2.26–1.44
60	0.37–0.24	1.26–0.57	1.50–0.96
80	0.25–0.13	1.26–0.59	1.13–0.72

Table 4 $1\frac{1}{2}$-In-Diam Journal-Bearing Tests—Results of More Favorable Material Combinations

Bearing	Journal	Diametral clearance (cold)	Load, psi	Remarks
Graphitar 14	Chrome-plated stainless steel	0.0025	20, 40, 60, 80	No wear, polishing
Tungsten carbide H-13	Tungsten carbide T-66	0.0024	20, 40, 60, 80	No wear, very light score, contact and static corrosion
Graphitar 14	Titanium carbide T-77	0.0018	10, 20, 40, 60, 80	No wear, polish
Graphitar 14	Stellite 12	0.0023	20, 40, 60, 80	0.0001 in. wear, light score, carbon trace
Graphitar 14	Stellite 1	0.0027	20, 40, 60, 80	0.0002 in. wear, medium score
Graphitar 14	Stellite 98M2	0.0025	20, 40, 60	0.0002 in. wear, medium score
Titanium carbide T-77	Titanium carbide T-77	0.0029	10, 20, 40, 60	0.0002 in. wear, medium score
Titanium carbide T-77	Tungsten carbide T-66	0.0024	10, 20, 40, 60	0.0002 in. wear, rusting
Graphitar 14	Stainless steel 18-8W Malcomized	0.0020	20, 40, 60, 75	0.0005 in. wear, contact corrosion slight scoring

carbon-graphite materials including the commercially available metal-graphite compacts. Of all the bearing materials tested, Graphitar 14 exhibited the most desirable properties. It showed the least wear and provided good resistance to galling and scoring. It also exhibited low friction in the boundary lubrication region or during actual contact at starting.

The extremely hard journal materials were found to operate best with a carbon-graphite bearing.

Metal-Carbon Compacts for Bearings

A further branch of this bearing program was directed at the development of a new bearing material.[9] It was desired to develop a material which would be satisfactory in water at 200 to 500 F, with impact strength in excess of that of known carbon-graphite bodies, and with other conventional desirable bearing characteristics. The procedure adopted was to provide a metallic skeleton for granular carbon so that some fraction of the desirable lubricating properties of carbon could be retained.

The first compact to be prepared was a 70 per cent nickel, 30 per cent copper alloy. It was fabricated by hot-pressing powdered ingredients at 2100 F and 6000 psi. After experimentation, a composition was selected containing 50 per cent graphite by volume and 60 per cent metal (70 per cent nickel, 30 per cent copper). At this composition, the structure consisted of a continuous metallic phase interrupted by dispersed graphite. It was believed that this interruption of the metallic surface would reduce wear as any incipient galling actions would not have access to a continuous metallic path across the wear surface. Greater additions of graphite resulted in a continuous carbon structure interrupted by the metallic phase. The impact properties of the latter structures were poor; hence greater percentages of graphite were avoided. Upon testing this material in an actual bearing it was found to seize immediately and after some further testing it was judged unsuitable.

Experimental work was then performed on cobalt-chromium-carbon mixtures. These alloy materials were hot-pressed at 2200 F and 6000 psi. An alloy of 70 per cent cobalt, 30 per cent chromium was chosen as it had the highest hardness without the brittleness of the higher-chromium alloys.

Carbon particles were added to the cobalt-chromium matrix in varying amounts from 15 to 30 per cent by weight. The resultant structures and impact values of the specimens indicated that a composition in the range of 15 to 20 per cent carbon by weight would be the most effective.

The impact resistance of the cobalt-chromium-carbon composites of a 50 per cent carbon (by volume) composition ranged from 5 to 7 times that of bearing grades of carbon graphite.

This material was then tested against journals of type 304 stainless steel chrome-plated and ran for 100 hr in 200 F water, the load being applied in steps to a maximum of 48 psi. Running areas were highly polished with no evidence of wear. This material was also prepared in the form of thrust-bearing shoes and performed well running against cold-pressed aluminum oxide. After hours of continuous operation at 200 F, 500 starts and stops were made successfully with this combination. When tested against a chrome-plated runner, however, it caused excessive wear of the runner.

Although this material has achieved success, it is felt that some further development would be warranted before its use as a bearing material could be recommended.

Conclusions

From the investigations thus far made in water lubrication, certain classes of materials appear to be definitely preferred. The best performance is observed when both journal and bearing are in the very hard range, and this is equally true if one of the bearing elements is carbon-graphite, a definite preference showing for the harder grades. The ceramic group has an impressive record of success as have many grades of tungsten-carbide and some of the stellites. The soft and medium-hard materials, especially the nickel-bearing alloys, are generally inferior as bearing components. Nitrided stainless steel performs well with hard grades of carbon-graphite, though some corrosion resistance is lost by nitriding.

Chrome-plated journals have shown good wear resistance against many bearing materials but are not considered desirable for service because of the danger of flaking and spalling. Very little has been said about surface finish, but its importance to bearing surfaces for water-lubricated service should not be underestimated. The thin lubricating films which exist require that the surface asperities be kept quite small. Finishes of 2 to 5 microinches are not uncommon. With modern machines it is often found that by the time a surface is lapped to required flatness or honed to required straightness, the specified surface finish is already achieved.

Equipment utilizing carbon-graphite in bearings may be designed conservatively for unit loads of about 35 psi. Some bearings are known to be operating considerably in excess of 100 psi, but their reliability is questionable.

Acknowledgments

Thrust-bearing tests were carried out at The Franklin Institute, Philadelphia, under the direction of F. S. Chaplin. Mr. Abramovitz was the project engineer. The description of the test machines and data in Table 1 are excerpted from Franklin Institute Report F-2243. Journal-bearing test work on the $2^3/_4$-in-diam bearings was conducted by Battelle Memorial Institute under R. W. Dayton. C. M. Allen and H. A. Van Dyke were in charge of the project. Description of the test machine and the data in Table 2 are from Battelle Report BMI-843. Test work on the $1^1/_2$-in-diam journal bearings was conducted at the Westinghouse Atomic Power Division Laboratories, Pittsburgh, Pa. Development of metal-carbon compacts was performed at the Armour Research Foundation, under W. Troy and Cord Sump. Appreciation is expressed to W. M. Wheildon of the Norton Company for his assistance in procuring the ceramic materials and related technical data.

The foregoing development program was carried out under the administration of the Westinghouse Electric Corporation with B. Cametti in general charge.

Important contributions to the development of water-lubricated bearings have been made by the U.S. Naval Engineering Experiment Station at Annapolis where the work was under the direction of Watt Smith.

[9] This phase of the program was carried out at the Armour Research Foundation, Chicago, Ill.

Controlling Engineering Costs

. . . or how to secure a high-quality finished project for minimum over-all engineering cost

By K. W. Reece

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ENGINEERING accounts for an important segment of the expense of building facilities to meet the needs of people everywhere. The magnitude of engineering cost depends upon the size of the project, its geographical location, and its complexity. The total expense may be as low as 2 per cent on a very large project and as high as 15 or 16 per cent of the total cost on smaller projects with many intricate problems present.

The engineering cost usually falls into three general categories: Preliminary investigations and planning; design and general engineering; field engineering during construction.

Control of engineering costs should not be directed solely toward cutting down with a view to getting a very low dollar expense for this work. The quality of the work, and its effect on the project, should be the primary consideration. However, within these limitations there is a wide field for money savings for the benefit of the client in envisioning the project, and putting that vision down on paper, ready for the construction forces.

Preliminary Investigations

A project generally starts as an idea. This idea must be developed, promoted, and financed before actual construction starts. The amount of work involved in doing this may be considerable and includes a wide range of talents.

The amount of money spent on this engineering phase of the project is controlled by the competence and experience of the people employed on it, the requirements of governmental bodies, and the need for information to solve the many business, legal, location, and technical problems involved. Management can do little to control such costs except to see that adequately qualified people are assigned to the job, to make sure that the objectives are kept clearly in view, and no lost motion is allowed to develop.

In some cases the client does his own preliminary work, and then the project is turned over to the professional-engineering organization to design. In other cases the preliminary work is done by the same organization that designs the project.

For purposes of simplification, this paper assumes that the location and general features of the project have been determined from the preliminary investigation by the time it has been turned over to the professional-engineering organization for design and general supervision of construction.

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Field Engineering

Field engineering during construction usually is an integral part of job supervision, and its cost is controlled by the same methods and supervision as is the total construction cost.

There are situations, however, where part or all of the design is done in the field as part of the field engineering. Where the construction work is let to a contractor on a unit-price basis, the owner may maintain an engineering organization to inspect the work, and make sure that the contract is being carried out as specified.

The author assumes that the job is designed and generally directed by a professional-engineering organization, that the field is furnished complete construction drawings as needed, and that no separate field-engineering organization is required.

General Engineering and Design

Fig. 1 shows the division of design and general engineering cost between the engineering component and

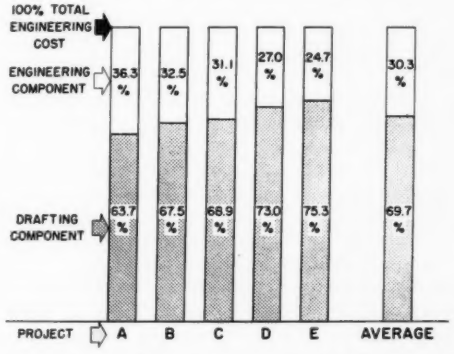


Fig. 1 Distribution of total engineering cost

the drafting component for five typical jobs. These proportions will vary between organizations depending on the division and classification of work. The dividing line between engineering and drafting is in many cases quite flexible and indeterminate. Also, department titles vary widely and in some instances a considerable amount of engineering work may be performed in the so-called drafting department and costs consequently recorded as drafting. In other instances the reverse may be true with a resulting lower percentage of total cost attributed to drafting. The important point is that by far the larger part of this portion of the engineering, regardless of terminology, is especially susceptible to sound

cost-control methods with resulting savings of substantial extent.

In a more leisurely period in engineering history the entire design of a project was completed prior to the start of construction work. This is still done to some degree when lump-sum or unit-price contracts are let for entire jobs. More and more, however, substantial savings in interest and other costs are realized by clients through

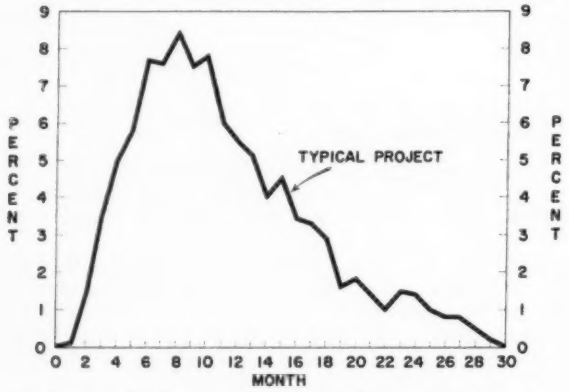


Fig. 2 Monthly engineering cost in per cent of total

starting actual construction very shortly after authorization and before the design work has progressed very far. Fig. 2 shows the typical distribution of the engineering cost of such a project with a 30-month period from start to completion.

Essential Factors

In organizing engineering work for the most efficient production at the lowest possible cost consistent with the highest quality, some essential factors must be recognized:

The engineering and design work is not an end in itself but must be integrated with the construction of the project.

A construction schedule is essential prior to scheduling the design work.

Purchasing should be scheduled to insure the receipt of manufacturer's drawings in ample time.

Decisions should be made early enough to allow the design work to go forward in an orderly manner. Changes are costly and should be held to a minimum. However, sometimes they are unavoidable or may be desirable. Changes should be made only after proper consideration has been given to technical and economic factors. It is usually wise to explain to the client the reasons for the change and that it will mean an increase in engineering cost.

Due dates for drawings should be established on a realistic basis. This cannot be emphasized too strongly. Once established, every effort should be made to meet the schedule.

The engineering and design-drafting personnel should be competent and also should be willing and able to produce rapidly and accurately.

These factors are requisite to achieving the lowest possible engineering costs, but of course they are even more important in insuring a high-quality project built on time and with a minimum of confusion and friction.

Organization

Good organization is prerequisite to control of engineering cost, in order to fix responsibility, make decisions, insure prompt transmission of information, coordinate the effort, avoid duplication.

It is easier to secure the desired results if the preliminary work, design, and general engineering and field engineering are done by the same organization. The personnel involved have had experience in working together. The preliminary work is generally carried out so that it can be picked up by the design and project engineers without lost motion. The designers know from experience the needs of the construction forces, and the field in turn knows just what to expect from the design office. These factors all make for lower engineering costs.

A type of organization for the design and general engineering work which has proved to be effective includes a group of department heads, consultants, and their staffs skilled in the various fields of engineering involved. This group is available for consultation, advice, and direction.

If the job is large enough, a co-ordinator is assigned to the job. His duty is to see that the job goes smoothly and that dates are met on schedule, not only in the case of drawings but, more importantly, that decisions are made, equipment specified and purchased, and all other items are handled promptly in order that the required construction drawings can be processed in a sequence that meets construction requirements.

A project engineer is assigned to each job from the engineering division whose services predominate or are controlling. General responsibility for a project is the project engineer's. A good project engineer must not only be technically qualified but must be qualified as an administrator and diplomat as well.

The design department is headed by a superintendent. It is set up in five divisions, namely, Architectural-Structural, Concrete-Hydraulic, Electrical, Mechanical, and Industrial—each with a chief. The staff in each division is divided into squads, of proper size to suit job requirements, and each is supervised by a squad leader. The squads turn out the design drawings.

This organization has many other duties but those just named directly bear on the control of the cost of the engineering work.

Tools for Control of Engineering Cost

Written schedules, estimates, progress reports, and records are necessary tools in controlling costs. The scope of the average job is so great, it moves ahead so swiftly, and the number of people engaged on it is so large, that proper supervision of cost by inspection, intuition, and impression is impossible.

The following ten forms, developed from long experience, are typical of those that are being used successfully:

1 A man-day estimate with list of drawings needed for the job, to serve as a basis for the engineering estimate and as an over-all control.

2 A cost estimate based on the man-day estimate, and priced out from experience records, including overheads and proper allowance for contingencies.

The estimate, once established on a sound basis, serves as a budget for all phases of the engineering work applicable to the specific project. An estimate is, of

course, only a target and must be used as such. In order to determine performance and progress, the following records are kept:

3 An engineering progress report, showing man-days expended on each drawing and cost to date, and per cent of budget expended.

4 A drawing schedule, with spaces for all pertinent information such as due dates, per cent of design completed, and engineering approval dates. Progress is recorded from start to completion.

5 A job-status report showing the detailed manpower situation. This is used to control assigned manpower.

6 A time report used by each individual for recording daily the time worked by jobs to the closest quarter hour.

7 Overtime report prepared by the individual when overtime is required and specifically authorized.

8 A work report, on which each man records, daily, to the nearest quarter hour the time worked by him by drawing numbers.

9 A record of drafting time for each drawing, compiled from the daily work reports.

10 An engineering-to-design information sheet, of the fill-in type, covering the usual primary data required prior to start of design, facilitates the transmission of necessary information from engineers to designers and draftsmen. It provides a check list of information and its proper use will prevent overlooking vital information required by the design department.

The foregoing list of information is basic; it is subject to adjustment, both in respect to omissions and additions, to fit special situations.

Getting Results

The best organization and the finest set of forms will fail of their purposes unless they are used efficiently. Teamwork is essential.

Engineering cost is largely made up of the time spent by professional and technical people who contribute ideas, services, and specialized work according to their abilities toward the construction of a useful project. By training and experience this class of people are accustomed to working together. By nature they are intelligent. By temperament they are individualists and opinionated. Best results are obtained from such people by leading them, and not by driving them. One of the most effective means of controlling engineering costs is to create and foster in each individual assigned to a project the feeling that he is playing an important part, no matter how small his contribution, in the successful completion of the venture.

The machinery will not work well without good management. The records for the purpose of controlling the cost must be well kept and be available promptly for the use of supervisors. Nothing is more useless than statistics that arrive after the need for them has passed. The various forms and reports are designed to show where overruns appear to be developing and the location of road blocks. Management should move promptly to correct such situations before they become serious. Generally, simple remedies will work; sometimes more drastic steps are necessary. Most projects move so swiftly that delays and undue deliberation will mean costs higher than they should be.

No formula can be laid down that will insure good management. However, some of the economies growing out of good management can be listed.

Drawings can be simplified greatly, with substantial savings in cost, and without loss of clarity. Minimum crosshatching and shading, greater use of adhesive overlays or "appliqués," showing only half of symmetrical objects, and more extensive use of freehand sketching are some of the ways to effect these savings.

Composite drawings in certain instances save drafting cost and reduce the number of drawings to be handled in the field.

All applicable standards should be followed.

The work can be planned to reduce overtime to a minimum.

The time required for breaks in work periods can be reduced greatly by delivering refreshments to the work areas and with no loss in the benefits of such breaks.

Time consumed in locating required drafting equipment can be reduced substantially by seeing that all drafting personnel are adequately equipped.

Key to Low-Cost Engineering

The lowest possible cost of engineering consistent with highest quality can be realized by such means as:

1 Establishing a cost atmosphere in the organization and developing cost-consciousness in all personnel on the engineering team.

2 Organizing with cost control as one of the major objectives.

3 Defining the major scope of the work early in the development of a project.

4 Releasing for production to design-drafting division only after major scope of work has been established and required detail information is available.

5 Being alert for more economical methods of doing the job.

6 Providing adequate standard forms and methods for recording charges and reporting progress as related to estimate and budget.

7 Making maximum use of established standards and simplification procedures, particularly in the design-drafting area.

8 Setting up an engineering budget.

9 Providing periodical review of progress and cost, checking the results against the budget, and correcting the unfavorable situations disclosed by the check.

10 Closing out the work as early as possible.

11 Never being satisfied with results from the cost standpoint. An economically produced job could always have been produced more economically.

The client is the principal beneficiary of the control of engineering costs. The savings to be obtained are substantial, and should receive the close attention of the professional engineer charged with the responsibility for the engineering work.

The drafting component accounts for a sizeable percentage of total engineering costs and close attention can be given to this component by elimination of non-essential details. In the aggregate their omission means a substantial saving for the client. In the author's opinion the worth-while objective of securing a high-quality finished project for the minimum over-all engineering cost can be accomplished by following the suggestions outlined herein for the control of engineering costs.

Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Associate Editor*

Automated Warehousing System

AN AUTOMATED warehousing system that uses electronically controlled conveyers and is said to reduce labor cost by 50 per cent and warehouse space up to 25 per cent as compared with conventional warehousing of equivalent capacity was introduced recently by Walter Kidde Constructors, Inc., of New York and Houston.

The conveyer equipment was developed in co-operation with the Link-Belt Company, and the controls in co-operation with The Teleregister Corporation. A prototype model for one application of this system has been built and operated at Link-Belt's Colmar, Pa., plant.

The warehousing system provides for the advantages of "bulk picking" while retaining the desirable features of conventional "order picking," it is claimed. In addition to reduced need for personnel and space, bulk picking offers better and more accurate inventory control, more efficient use of warehouse storage space and reduction in breakage, returns, errors, and similar warehousing "headaches."

This development is important to any industry or business which must warehouse and distribute case and broken lots of a wide variety of products, such as chain stores, drug wholesalers and chains, large manufacturing companies, etc.

The bulk-picking method is facilitated through use of an "automated" conveyer system directed by electronic controls. The conveyer provides a platform on which pickers can place and segregate a requested item together with the consignee's address—which is contained on a tabulating card. It transports and then discharges each carrier load at a collecting station assigned to a specific destination for packaging, if necessary, and shipping. The discharge chutes are designed to act as temporary storage until the roving packing and shipping crew loads the trucks.

Order Versus Bulk Picking

Most, if not all, warehouses operate on the order-picking principle. The picker in the warehouse is given customer's orders as they arrive and he goes from picking area to picking area selecting items requested. During a working day, he must retrace again and again the pattern of movement from area to area, since the same items are requested on numerous orders.

This work pattern is essentially inefficient, it was pointed out. Mechanization through use of hand carts, powered hand trucks, and fork trucks alleviates but does not avoid this waste of time and effort. Bulk picking, on the other hand, attacks the root of the problem. By picking the total quantity of a particular item required to fill all the orders scheduled for a given work period, the picker need visit a specific area only once during that time interval.

In one warehouse studied by Kidde engineers, 6900

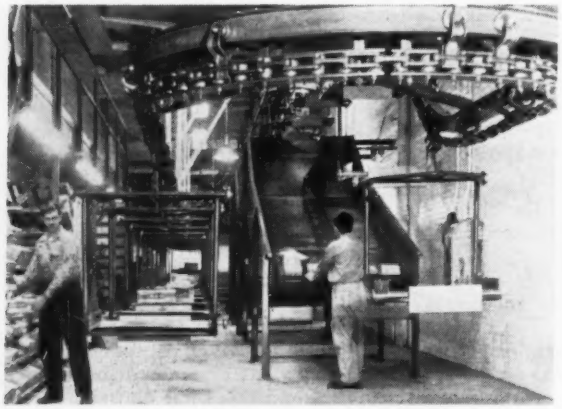


Fig. 1 Automated warehousing system operates on the bulk-picking principle. In this prototype of the key components for one application of the Kidde System, the man at left is picking a case from the gravity-feed shelves and will place the case, together with a punch card, on one of the carrier trays. The man at right is standing at a discharge chute ready to load the shipment for the customer assigned to that chute.

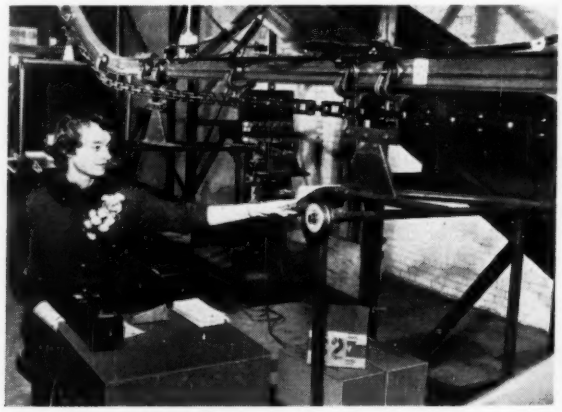


Fig. 2 After the carriers leave the picking area, the conveyer takes them to the dispatching station. The dispatcher removes the punch card from each tray and inserts the card in an electronic card reader. The card is inserted in the metal guide that projects out of the stand. The card reader is used to activate conveyer controls which cause a picking tray to gently discharge its load into a predetermined chute.

of a total line of 9100 items were called for in the orders filled on that particular day. Over 35,000 picks at the reserve-stock areas, picking racks, and bins were required to fill the orders. During the working day pickers traveled over one million feet to make the picks. At that same warehouse, using the Kidde automated system, the identical orders could have been processed in one batch with only 7000 picks while traveling only 10,000 ft, the Kidde report concluded.

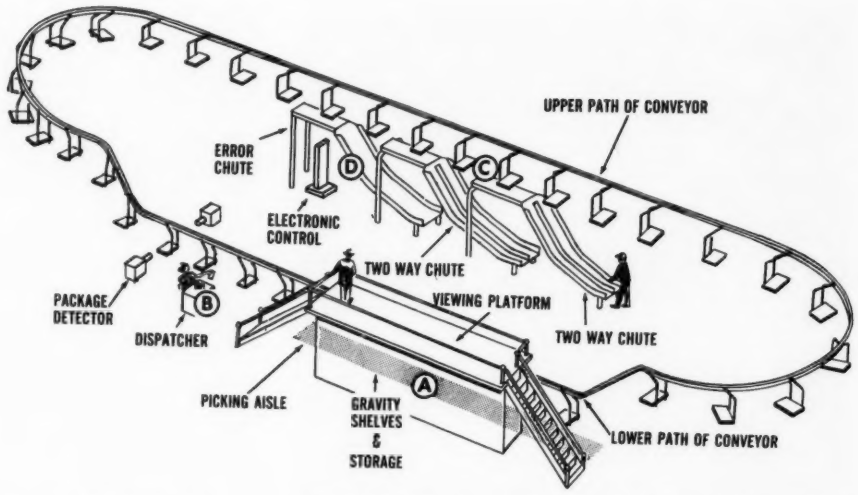


Fig. 4 Operation of prototype of Kidde Warehouse System. (A) Items selected from storage by punch card, placed on moving tray, and transported together to dispatching area. (B) Dispatcher removes and inserts card into card reader. (C) Electronic controls punch paper-tape analog. At destination, unloading cam removes item from tray. Gate directs to proper station. (D) Dispatcher can rectify keyboard mistake with error chute. Photoelectric package detector removes all unaddressed merchandise.

Bulk-Picking Storage

In the conventional warehouse, storage is divided into reserve stock and picking stock. The latter consists of less than case-lot or pallet-lot items stored in bins or racks. Reserve stock is palletized and floor-stacked and used to replenish the picking area and for pallet-lot orders.

With the Kidde System, only a small portion of the warehouse is needed for reserve; the major portion is devoted to active storage for picking. This saves substantial aisle space that ordinarily would be needed to permit traffic between the reserve stock and the picking area.

A typical Kidde warehouse section consists of 8-ft-wide storage areas with alternate picking and stocking aisles.

Incoming merchandise is handled by any one of a number of means including fork trucks, tractor-towed trains, or Trukveyers (endless-chain pulled carts)—palletized or unpalletized. Stocking aisles are used by the equipment to deliver incoming stock.

Items handled in less than case lots are stored in gravity shelves, no more than 6 or 7 ft high on the picking aisle side, so that pickers can easily reach the top shelf. Above the shelves are racks for palletized storage of additional stock to supply the gravity shelves.

Bulk or cased merchandise is floor-stacked or rack-stacked on pallets. On the picking-aisle side, stacks are maintained at the 6 to 7-ft height so that the picker can reach a case easily; on the stocking side, stacks can be 16 ft high or more. Roving stockmen work up and down stocking aisles to maintain the gravity shelves and the picking stacks. Since pickers always remove from the front of the shelves or stacks, this system assures first-in first-out inventory movement.

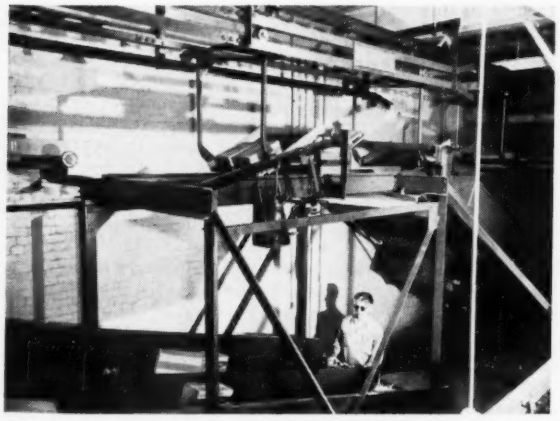


Fig. 3 By inserting the punch card in an electronic card reader, a relay is energized and the picking tray is tilted to eject its merchandise into a discharge chute. An overhead trolley conveyer controlled by an electromechanical analog is used. Here, a relay has just caused one of the trays to discharge its load, and the pusher plate on the following tray will push the merchandise into the gently sloping discharge chute.

Bulk-Picking Operation

Incoming orders are broken down, by items requested, on punch cards which also contain customer's name, address, and other pertinent data. Cards are arranged according to stock sequence and given to the picker, who covers a specified number of stations. The picker starts at the first station, the storage area for brushes, for instance. The first card calls for two units; he picks two and places them, together with the card, on a carrier tray attached to a moving conveyer. He repeats this until all of the cards for that station have been processed. He then moves to the next station and repeats the operation, and so on.

The conveyer takes the carrier trays past the dispatch booth, where the dispatcher removes the card and inserts it in a device called a "card reader." This device activates the conveyer controls so that the tray discharges its load at a predetermined chute serving a particular customer, truck, or route.

Fig. 5 This hollow tube being held by a Bell Telephone Laboratories' engineer is the newest look in telephone and television transmission. It is an experimental long-distance waveguide, made of flexible copper, 2 in. in diam.

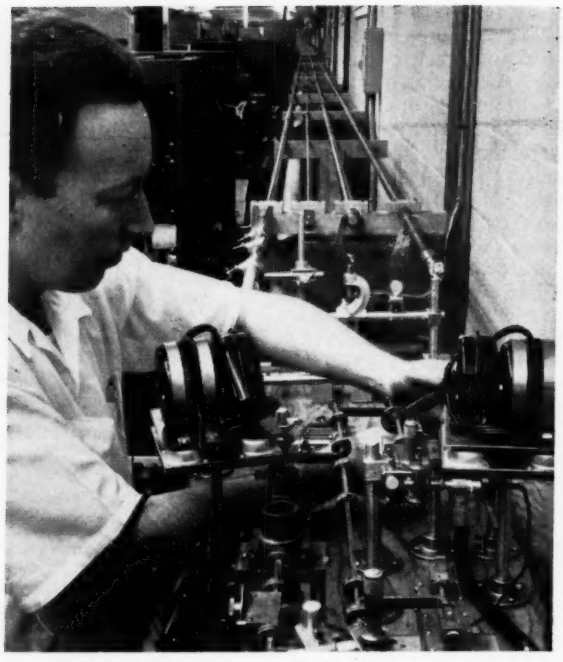


Fig. 6 An engineer tests transmission through long-distance waveguides of various sizes at Holmdel, N. J. The long-distance waveguide may join coaxial cable and radio relay as a heavy-duty transmission medium for the Bell System.

Long-Distance Waveguide

A DIFFERENT method for transmitting television and telephone conversations over long distances has been used successfully in experiments, Bell Telephone Laboratories announced recently.

The new medium, a long-distance waveguide, is markedly different from modern cable or radio-relay systems—it uses hollow metallic tubes roughly 2 in. in diam.

Bell scientists believe the new waveguide may someday simultaneously carry tens of thousands of cross-country telephone conversations along with hundreds of television programs. Top capacity for the most modern of coaxial-cable systems is 1860 two-way telephone conversations or 600 such telephone conversations and two TV programs simultaneously on a pair of coaxial tubes. Modern coaxial cables have eight such tubes, two of which are kept as spares for emergencies.

Waveguides made of solid metal tubing—roughly like a metal water pipe—have been used widely for some time for short distances. It would be possible to use these solid metal tubes for long distances if they were perfectly straight, but this is impractical.

The new long-distance waveguide is also a hollow tube, but it is constructed of a thin copper wire, very tightly coiled—like a spring under pressure—and wrapped inside a flexible outer coating which holds the coiled wire in place. This type need not be straight and can actually carry signals around corners.

Experiments indicate that both the solid-tube-type waveguide and the new coiled-wire or "helical" type of waveguide can be used together in communications systems, the first for short distances and the latter for long distances.

Recent experiments at Bell's Holmdel, N. J., laboratory indicate that the new waveguide transmission is extremely promising and might, when fully developed, join coaxial cable and radio relay as an everyday transmission medium for the Bell Telephone System. Engineers hope to use the new waveguide in a variety of ways; one of these might be with a heavy protective coating so that the hollow tubes are run underground.

Although this new form of transmission is still in the experimental stage, a recent long-distance test was made at Holmdel in a copper pipe 500 ft long. Engineers bounced signals back and forth in the tube for distances of 40 miles. They calculated that, in comparison, the same waves could have traveled only 12 miles in a coaxial cable with the same loss in strength.

The new transmission system operates in a frequency range so high that it has never before been put to practical use for communications. As a matter of fact, this range is so high that engineers do not have a name for it yet although the short waves used are known as millimeter waves. The "superhigh" frequency range established by the Federal Communications Commission goes up to 30,000 megacycles. The carrier frequency for the new waveguide is about 50,000 megacycles.

A major difference between transmission through the new waveguide and through previous systems is that the higher the frequency in the waveguide, the less the loss through attenuation. This is exactly the reverse of other forms of transmission.

During World War II waveguides were used to funnel radar signals from an antenna to receiving equipment.

Fig. 7 This hoselike tube is the Bell Telephone Laboratories' new long-distance waveguide, a radically different means for transmitting television and telephone conversations. The flexible tube channels radio waves any way it is bent.

Similar waveguides and others of a more advanced design are now in use in the Bell System to carry signals on microwave radio-relay towers. Some of these, as well as the new long-distance waveguide, are round.

Beyond the prospect of an improved transmission with the long-distance waveguide is the possibility of learning how to use tiny wave lengths on the order of one millimeter. If this should become possible, the waveguide of the future may be no thicker than a fountain pen and still carry tens of thousands of telephone messages.

Nuclear-Power Equipment Plants

Babcock & Wilcox Company

PLANS for the construction of a privately financed major plant for the manufacture of fuel elements and other reactor-core opponents for the nuclear-power industry, were announced by the Atomic Energy Division of The Babcock & Wilcox Company. The plant, to be located about 5 miles east of Lynchburg, Va., is expected to be completed by the end of the year, the announcement said.

The proposed site of approximately 500 acres bordering the James River has been selected in accordance with regulations used by the Atomic Energy Commission in selection of government sites. The main building will be a one-story structure of approximately 100,000 sq ft, and will house various laboratories and offices as well as the complex manufacturing equipment.

B&W announced last year that it anticipates making complete nuclear steam generators for the production of electric power. The company has already developed and fabricated special equipment for many of the major atomic-energy installations. The new plant will provide properly designed facilities for the manufacture of many types of special equipment for this rapidly growing industry.

B&W has been active in the atomic-energy field since 1942 and has contributed materially to both the defense and peacetime aspects of atomic-energy development.

The company designed and built vital equipment for the USS *Nautilus*, the world's first atomic submarine, and will also furnish much of the equipment used to power the second atomic sub, the USS *Sea Wolf*. In addition, B&W is supplying much equipment for large-scale nuclear tests in the national laboratories and has developed and placed on the market three low-cost reactors which can be used by colleges and other organizations for research and training purposes.

As a leading producer of steam-generating equipment for utilities and heavy industry, B&W was one of the first to investigate the feasibility of utilizing the heat from nuclear fission to produce electric power. During the past several years the company has been doing a considerable amount of developmental work in association with various utilities and industrial concerns with that purpose in mind.

Combustion Engineering, Inc.

New plant facilities, also for the manufacture of nuclear-power equipment, will be the major part of a long-term expansion program of Combustion Engineering, Inc., of New York, N. Y. An initial appropriation of $7,000,000 has been approved by the company's Board of Directors.

Ground has been broken for a new building to be located at the company's Chattanooga, Tenn., division that will have the most advanced manufacturing equipment available for the production of nuclear reactors. A specially designed wharf will also be built on the Tennessee River frontage of the plant so that large component parts of nuclear installations can be transported by barge. The program will be completed in 1956.

The new facilities, it was pointed out, will place Combustion Engineering, Inc., in a position to design and build complete nuclear-power plants up to the turbines.

The Atomic Energy Commission also announced recently that the company has received Commission approval for a study of design and evaluation of large reactors for central-station power production and small reactors for special applications. The study will include development of fuel-element fabrication processes.

The company has already built major reactor components for the prototype of the submarine *Sea Wolf* in the sphere at West Milton, N. Y., and is presently building both reactor components and the boilers for the *Sea Wolf* itself. Among other important work in process is the huge reactor vessel for the power station to be built for the Duquesne Light Company near Pittsburgh, Pa., which will be the first commercial-size nuclear-power plant in the country.

The new building at Chattanooga will be equipped with heavy-duty cranes, large boring mills, and other machines capable of fabricating parts to the extremely close tolerances and fine surface finishes required for a nuclear-power plant. A particularly notable piece of equipment will be a 15,000,000-volt betatron, a machine capable of fast x-ray inspection of steel castings, forgings, plates, and welded joints, many inches thick. Certain

areas of the building will be supplied with filtered air under pressure to maintain the dust-free atmosphere required in nuclear work.

The loading apparatus at the new wharf will be capable of handling reactor vessels weighing up to several hundred tons.

Private Research Reactor

THE first nuclear reactor designed for private industrial research will be built for the Armour Research Foundation by North American Aviation, Inc., it was announced recently.

It is proposed to locate the new reactor at Armour's operations on the campus of the Illinois Institute of Technology in Chicago, Ill., not far from the site of the historic Stagg Field reactor which heralded the modern atomic age. Unlike the Stagg Field machine, the new industrial research reactor will be used entirely for nonmilitary or "peacetime" applications of atomic energy.

Construction will begin when the project has been approved by the Atomic Energy Commission. Fissionable material for the operation of the reactor has been requested from the Commission under the licensing provisions of the AEC Act of 1954.

The reactor and associated equipment are expected to cost about $500,000.

Short-lived radioisotopes, useful in medical, industrial, and scientific research, will be available locally from the new machine. Such "short-lived" isotopes have not been widely used because of the time delay and resultant radioactivity loss if moved over long distances.

Scheduled to be completed in about a year, the reactor will be available to industrial and government sponsors to conduct a wide range of nuclear research. Capable of operating at a power level of 50,000 watts, the reactor will produce neutrons and gamma radiation for research and development in the fields of biology, metallurgy, food processing, electronics, chemistry, textiles, oils and gases, rubber and leather, machinery-building materials, and allied industrial and scientific pursuits.

The reactor will be located in a room about 48 ft long, 72 ft wide, and 30 ft high. Atomic fission, which produces radioactivity and neutrons, will take place in the reactor core, a steel sphere about one foot in diameter. The sphere will contain about four gallons of uranyl sulphate, enriched in uranium 235, in a water solution. Because of this arrangement the reactor is called a "solution type."

The reactor core will be surrounded by an 8 × 5 × 5-ft stack of graphite bars which act as a reflector. The graphite stack is completely enclosed in a steel tank, except for those areas opened to permit access to the radioactivity and neutron supply from the core. Five-feet-thick dense concrete blocks form the exterior shield for the machine, giving an over-all dimension of 18 ft long, 16 ft wide, and 11 ft high for the shielded reactor structure.

Rate of fission in the reactor will be controlled by four boron rods. These rods, when placed near the reactor core, absorb neutrons, thus stopping the fission process. When the rods are withdrawn fission begins again. With this control it is possible to operate the reactor at various power levels by regulating the rate of fission.

A particular feature of this reactor is its "self-contained" design which confines all the radioactivity within the shield. No fumes, gases, smoke, or any other materials will be exhausted or discharged from the machine. This design, together with the inherent safety features of the solution-type reactor, make it particularly suitable for the Armour research program.

Fissionable material to "fuel" the reactor will be ob-

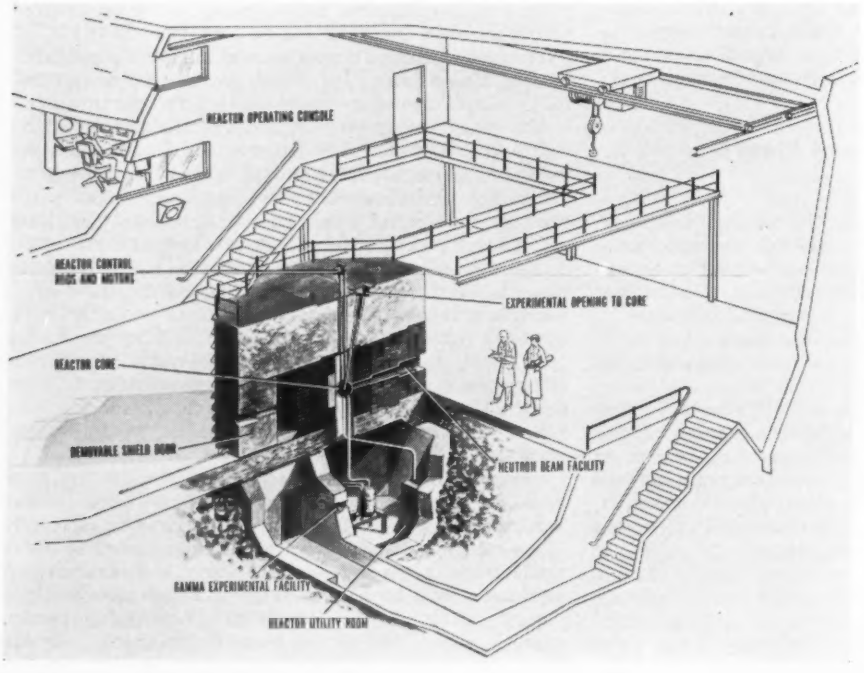


Fig. 8 Artist' sketch of the first nuclear reactor for private industrial research which North American Aviation designed and will build for the Armour Research Foundation. The 50,000-watt reactor will be located at Armour's facilities on the Illinois Institute of Technology campus and used to develop the peacetime applications of atomic energy.

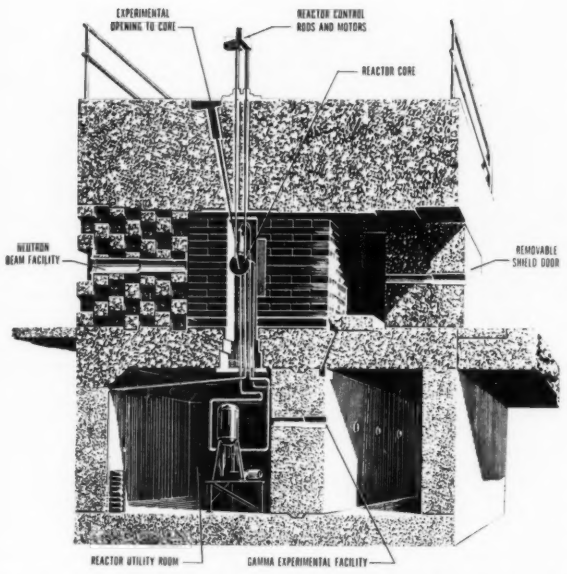


Fig. 9 Atomic fission, which takes place in the North American-Armour reactor core, *center*, produces neutrons and radiation useful in medical, industrial, and scientific research. The reactor will be located underground and shielded by 5-ft-thick dense concrete blocks. A solution-type reactor, the machine has inherently safe operating characteristics.

tained from the Atomic Energy Commission on an "extended-loan" basis. Armour officials have pointed out that sponsored research with the machine will be subject to no competition from military applications, no secrecy of any kind other than that called for in the protection of the individual sponsors programs. The machine will not be used for research on reactors or electric-power generation.

The Armour reactor was designed by North American's Nuclear Engineering and Manufacturing Department at the company's Downey, Calif., plant. North American also is participating in the Atomic Energy Commission's five-year program for the development of economical electric power from atomic energy. In a jointly sponsored project with the Commission, North American is constructing an experimental 20,000-kw sodium-graphite power reactor near Los Angeles, Calif.

Portable Thulium X-Ray Unit

THE U. S. Atomic Energy Commission announced plans to assist private industry in the commercial development of portable thulium x-ray units.

Development of a small, relatively inexpensive, and portable device by the Argonne National Laboratory near Lemont, Ill., was announced last spring. Numerous requests for information regarding the unit have been received since then from potential users and from manufacturers wishing to develop it for commercial production. Each unit contains about 200 milligrams of radioactive thulium metal or oxide, pressed into an aluminum capsule. The capsule is recessed into a small cylinder which rotates within an outer shield of lead. The entire unit is approximately 6 in. in diam, 7 in. long, and weighs about 20 lb.

The AEC will not engage in the commercial production of the thulium or in the manufacture of the units. It is expected that private industry will be able to supply the potential market. Technical information and limited consultation will be provided to firms interested in the commercial development of the units.

AEC assistance will take the following forms:

1 Nonradioactive thulium will be irradiated in the Materials Testing Reactor at the AEC's National Reactor Testing Station in Idaho and elsewhere. Cost of the unirradiated material will be approximately $10 per unit of 200 milligrams, and cost of irradiation will be about $100 per unit.

2 Argonne National Laboratory will make available, on a loan basis to industries, a limited number of thulium radiation sources in aluminum capsules. A charge of $50 will be made for each three months' loan of the activated source.

3 Argonne National Laboratory will make available on a loan basis a limited number of assembled thulium x-ray units to qualified industrial firms and nonprofit institutions for developmental studies and for experimental field applications in research and medicine. Loans will be made for a maximum period of three months, and a service charge of $100 will be made for each loan plus a deposit of $300.

A fact sheet on the unit has been prepared for use by interested firms. It provides information on the design of the unit, the cost and availability of thulium and irradiation services, and the conditions applicable to the loan of such units. Information also is available on the methods of separation of thulium from rare earth ores and its conversion into the metal or oxide of sufficient purity for radioactivation.

Requests for copies of the fact sheet or information on arrangements for loans of portable units should be sub-

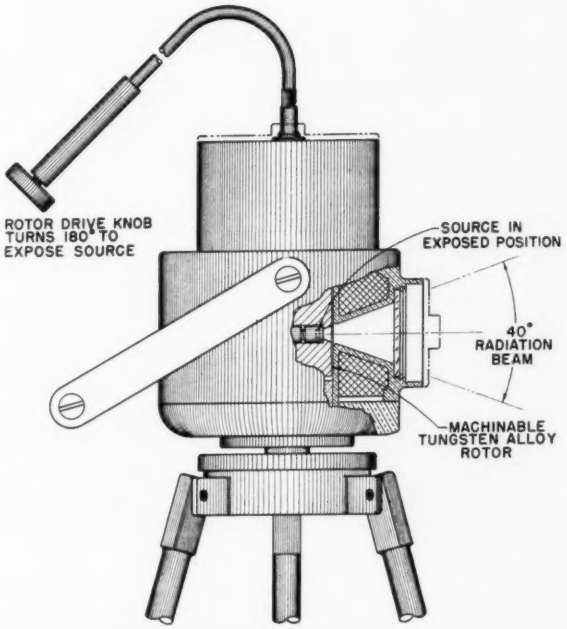

ROTOR DRIVE KNOB TURNS 180° TO EXPOSE SOURCE
SOURCE IN EXPOSED POSITION
40° RADIATION BEAM
MACHINABLE TUNGSTEN ALLOY ROTOR

Fig. 10 Sketch of portable thulium x-ray unit—Model 4

mitted to the Technical Services Division, Chicago Operations Office, U. S. Atomic Energy Commission, P. O. Box 59, Lemont, Ill.

Phenolic Adhesives

Two new modified phenolic adhesives, which provide considerable strength and service qualities in high temperature and humidity environments, have been developed by North American Aviation, Inc., at Downey, Calif.

"NAA Hi-Temp" is used for bonding metals and reinforced plastics. "CHT," a modification of "Hi-Temp," is used in the fabrication of heat-resistant "sandwich constructions."

Adhesives are said to be of great value in the aircraft industry because of their advantages in saving weight, time, and costs. Numerous potential applications also exist in automotive, electronic, and other industries.

The requirements of adhesives have become more stringent with the advent of supersonic aircraft which develop high skin temperatures in flight. The North American-developed adhesives were designed to meet these requirements.

The sandwich type of construction consists of a lamination of metals, plastics, or woods having an inner core of intermediate strength, low-density material, and outer facings of a relatively thin, dense, higher-strength material. The method offers excellent weight-to-strength and stiffness-to-weight ratios and permits simplified tooling.

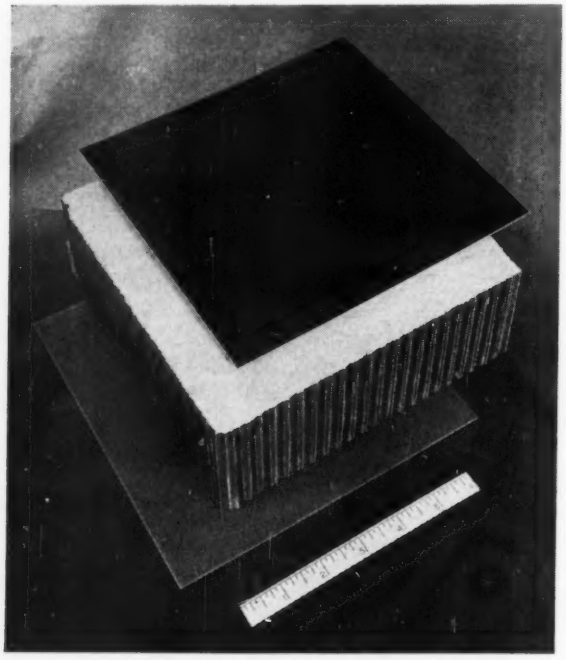


Fig. 11 This phenolic-base sandwich structure is composed of a honeycomb core sandwiched between plastic laminate facings. Supported by North American Aviation's newly developed CHT, a modified phenolic adhesive, this type of construction is used in structural and electrical applications which may be subjected to elevated temperatures of 200 to 500 F.

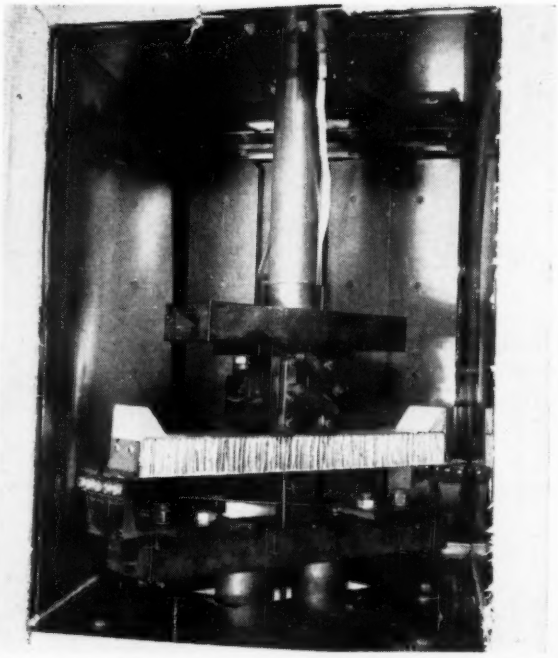


Fig. 12 In this flexure and heat test conducted by North American, the adhesive bond of this sandwich-constructed member withstood a load of 690 lb at 500 F, even though the aluminum honeycomb core sheared. When bonded to aluminum facings with CHT the honeycomb material results in a sandwich construction which gives excellent service under high-temperature and humidity environments.

Sandwich construction has become increasingly important in the last decade due to demands of entirely new design factors and weightsaving requirements of military aircraft.

Recently developed aluminum-honeycomb-core materials are presently being used in sandwich construction for the fabrication of secondary aircraft structures such as fairings, bulkheads, floor panels, and partitions. When bonded with CHT to aluminum facings, the honeycomb material results in a sandwich construction which gives excellent service under high-temperature and humidity conditions.

CHT is applied only to the facing surfaces and need not be applied directly to the core material. Both the top and bottom facings may be joined to the core in one curing operation, resulting in a simplified and timesaving operation.

Two companies, Rubber and Asbestos Corporation and American Latex Products Corporation, have been licensed by North American to manufacture and market the new adhesives.

Die-Casting Industry

According to the American Die Casting Institute of New York, N. Y., 1955 is expected to be the best year in the history of the die-casting industry. This estimate is based on increased civilian aluminum die-casting uses, plus the greatly expanded use of zinc die castings in automobile front ends.

The increased automotive die-casting consumption and applications in major-appliance industries spurted 1954 job-shop sales to $268,000,000. Of the four metals which are die-cast commercially, zinc was the leader by weight. Job-shop output of zinc-base die castings was 292,000,000 lb. The die-casting industry consumes over 38 per cent of the nation's slab zinc output, second only to galvanizing. Aluminum job-shop die-casting production totaled 168,000,000 lb. Of the nation's aluminum-casting ingot, 42 per cent is fabricated by die casters.

Job-shop magnesium die-casting volume for 1954 reached 3,720,000 lb. Magnesium die-casting output is reflected in high aircraft use of die-cast parts, where the lightweight metal used for various components translates into greater aircraft pay load. With the newly developed hot-chamber, high-speed magnesium die-casting machine, greatly increased consumption of the metal is indicated in coming years.

Job shops processed 3,785,000 lb of copper-base or brass die castings. The higher melting point of these copper-brass materials reflects in restricted applications. The Institute's present research into higher-temperature-resistant die materials promises to increase drastically the use of brass die castings in the near future.

Sales volume during 1954 marked the second highest attained by the industry. The American Die Casting Institute estimates that 1955 will reach a record of some $400,000,000. Supporting this estimate is the greatly increased consumption by the automobile industry. The major appearance of zinc-cast grilles and other front-end parts—almost 40 lb on one car—coupled with the auto manufacturers' 1955 plans for 5,700,000 vehicle production, virtually guarantees a record high in zinc. Typical of the auto industry's requirements is its 1955 demand for 76,000,000 die-cast door and window handles.

New aluminum applications, especially in the major-appliance field—second largest die-casting market—are reflected in this metal's rising consumption. Office and home appliances such as typewriters and sewing machines, once produced from cast iron, are now produced with aluminum die castings. The rapidly growing "do-it-yourself" market has also increased consumption of aluminum die castings because almost all portable home-power tools (and industrial equipment,

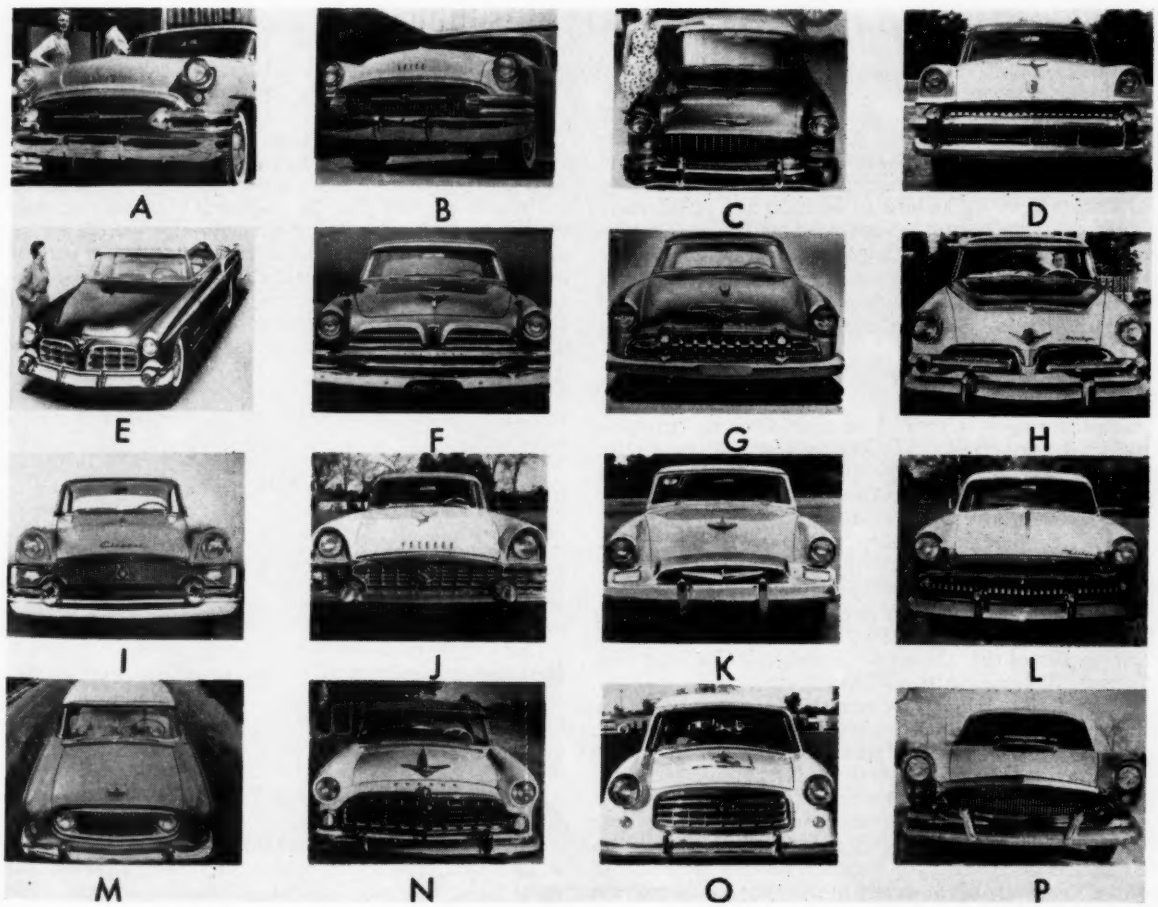


Fig. 13 Sixteen different 1955 U. S. automobiles featuring zinc die castings in their front ends: (A) Buick—Special and Century; (B) Buick—Roadmaster and Super; (C) Chevrolet; (D) Mercury; (E) Imperial; (F) Chrysler; (G) DeSoto; (H) Dodge; (I) Clipper; (J) Packard; (K) Studebaker; (L) Willys; (M) Nash; (N) Hudson; (O) Rambler; and (P) Kaiser.

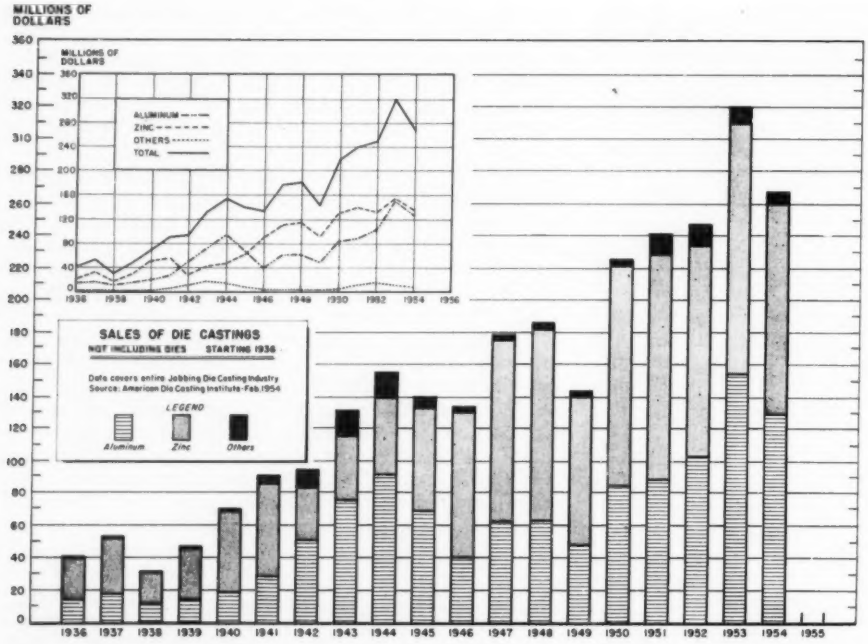


Fig. 14 Sales of die castings, not including dies, starting in 1936, as compiled by the American Die Casting Institute

too) are housed in die-cast aluminum. Magnesium applications in the photographic-equipment industry are also rapidly expanding to include not just camera housings but also projectors and flash guns. This photo-equipment expansion, coupled with the high use for aircraft components, plays a major role in boosting magnesium-sales outlook.

Secrecy—Yes or No!

SECRECY in basic sciences, which involves the "exploration of the unknown," is "a dangerous and subversive influence," Lee A. DuBridge, president of the California Institute of Technology, maintained in a recent lecture at Yale University. He said that contrary to public opinion "the first and primary thing one does with a new discovery in science is to publish it," because "only when it is published can it be openly examined, criticized, and tested to find out if it is really true."

President DuBridge delivered the Embree Lecture at Yale as part of this University's six-week Conference on Responsible Leadership in a Democracy.

He said that while this seems very elementary to a scientist, "there are many people who really believe that because scientists habitually publish their scientific findings, they are not good security risks because they will want to give away weapon secrets."

Asserting that "the power to protect science no longer lies solely in the hands of scientists or even of those who understand its methods and aims," he said that "those who are unaware of the nature of free inquiry can participate in destroying it."

He maintained that in the prosperous, strong, but fearful America of 1955 there is a danger that even the scientist himself "will forget that his primary functions are still to learn, to teach, to experiment, to seek understanding, to discover ignorance and errors, to gain new ideas and then to challenge them, to prove or disprove them, and always to exchange ideas with others—fully, freely, honestly, vigorously."

According to President DuBridge, the public must be taught that "secrecy does not necessarily keep things secret." This is true, he explained, "because the secrets in science and technology are wrested from nature. And nature gives the same answers on both sides of the Iron Curtain."

"All our secrecy can do is to slow down the enemy's progress," he said. "Since it also necessarily slows down our own, the relative risk or advantage is often difficult to weigh."

He also pointed out that "if we trust no one with secrets, then there will be no secrets—for secrets are invented in the brains of fallible human beings. If we disqualify every competent but slightly 'imperfect' scientist from working for our government, then we shall surely fail to survive as a nation in the modern world, for scientists are essential and few of them are wholly 'perfect.'"

"This is especially true," he continued, "if the definition of perfection includes the requirement that we have never known any of the 'wrong' people."

Continuing, President DuBridge said that as far as most scientists are concerned, federal employment is neither a privilege nor a right "but only a burdensome patriotic duty."

Emphasizing that "scientists are scarce, especially the really good ones that the government so often needs," he said that "the government ought to be out offering positive inducements to them."

Instead, he maintained, almost the opposite policy is followed.

In the case of valuable men who can only be obtained for a short time or on a part-time basis, "why waste most of the period on unnecessarily elaborate security-clearance procedures—especially if he has already been cleared by other agencies a dozen times before."

Yet, he said, such a practice is followed.

"In view of complex government red tape, the rigidity and inappropriateness of many civil service and clearance procedures, the problems of fluctuating budgets and unnecessarily rigid purchasing, reporting, and hiring procedures, it is doubtful whether there is much hope that the government will regularly attract the best

brains of the country into its own establishments," he said.

The reason for this condition, according to President DuBridge, is that "a Congressman who has just exhausted himself to be elected to a government job cannot believe that some people don't want government jobs and hence sees no necessity for trying to make them more attractive."

As an alternative to this dilemma, he recommended that the government "contract this task of military research to private organizations who know how to attract good people."

He also urged the appointment of scientific advisers for all governmental agencies, including Congress. At present, he said, "problems ranging from the question of whether to draft scientists to whether tactical A-bombs could be effectively used in a small war are being debated without full access to the scientific facts—without, indeed, any realization that such facts may be important.

"Worse still," he complained, "when such facts are brought forward by men of competence they are often 'ignored' because of the prevailing idea that anyone who knows what he is talking about 'must clearly be prejudiced.'"

President DuBridge blamed the scientists themselves for part of this situation. "We ourselves have not been able to devise a suitable mechanism whereby the best and most balanced scientific thought of the country can be focused on the country's most important problems," he said.

But, he warned, "we must find such a mechanism. Problems of a large technical content cannot be satisfactorily solved by Gallup polls or even by the election returns."

Aerosoloscope

An electronic instrument which measures and counts microscopic air-borne germs, dust, and moisture particles has been developed by Nelson E. Alexander, an Army Chemical Corps Engineer at Camp Detrick, Md.

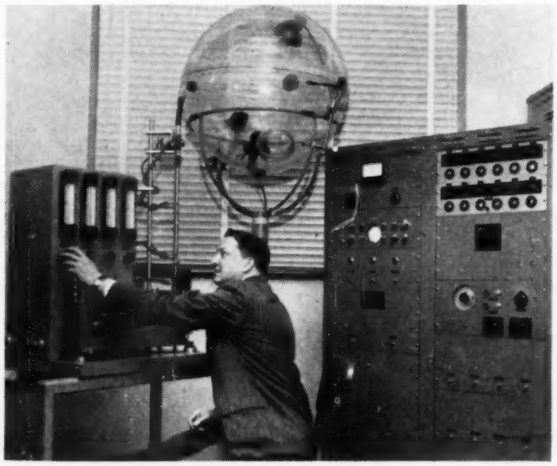


Fig. 15 Nelson E. Alexander, Army Chemical Corps engineer, adjusts aerosoloscope, a device developed by the Army for counting and measuring microscopic air-borne germs, dust, and moisture particles. The instrument is capable of counting and measuring particles ranging in size from one micron (forty-millionths of an inch) to 64 microns at the rate of 6000 per min.

Known as an aerosoloscope, the device measures and counts air-borne particles, one at a time, at the rate of 100 per sec. It is equally capable of counting radioactive particles and determining their size.

Mr. Alexander foresees extensive use of the device by public-health agencies and industry as well as by the defense establishment.

Air-borne particles ranging in size from one micron to 64 microns are counted and measured by the aerosoloscope 1000 times faster than by the ordinary method of collecting them in a medium or on a suitable surface and then examining them under a microscope.

The instrument, it is said, eliminates many of the inaccuracies occasioned by particle instability, evaporation, agglomeration, and mechanical distortion in counting with a microscope.

The principle of the aerosoloscope is based on the phenomenon that the dust particles or "specks" observed in a shaft of light are, in fact, only reflections of the particles themselves.

As air-borne particles in concentrations of up to 15,000 per milliliter pass through the instrument they are diluted and their flow rate is controlled in such a way that each one is individually illuminated.

The reflection caused by the illumination is detected by a photomultiplier tube. Since large particles reflect more light than small ones, the photomultiplier tube, in conjunction with other electronic apparatus, is able to determine the size of each particle.

Electrical impulses created by the photomultiplier tube when it detects reflections are transmitted to a set of 12 dials.

The first dial records the number of particles 1 to 1.4 microns in diameter. Each succeeding dial records slightly larger particles than the preceding dial. The twelfth dial records the number of particles 45 to 64 microns in diameter. (The increases are in multiples of the square root of two.)

If necessary, the instrument can be modified to measure particles smaller than the present limitation of one micron.

The history of the aerosoloscope goes back about six years when construction started on a preprototype model. In early 1951 a contract was placed with the Armour Research Foundation to develop a prototype and construct the two complete and usable instruments since installed at Camp Detrick.

A counter, similar in certain respects and based on the same physical principles, was developed independently by Prof. Frank T. Gucher, Jr., now at the University of Indiana.

Smog Mufflers

Actual road testing of six separate Houdry catalytic converters to control the smog formers in auto exhausts was started recently in San Antonio, Texas, according to the Air Pollution Foundation in San Antonio.

The converters, described by the Air Pollution Foundation as "among the most promising devices to control the emission of smog-forming hydrocarbons," have been installed on automobiles which are being given 20,000-mile road tests by the Southwest Research Institute at San Antonio, under a contract with the Air Pollution Foundation.

Fig. 16 New antismog muffler being tested by Air Pollution Foundation is shown attached to underside of car for road tests at San Antonio, Texas. Muffler's inventor, Dr. Eugene J. Houdry, claims hydrocarbons in engine exhaust gases are burned completely to harmless carbon dioxide and water in catalytic muffler, which is the twin-box structure at center.

The Houdry converters are being tested on six different cars, following a strict driving pattern simulating average auto usage in the Los Angeles area. Some of the cars are using red or leaded gasoline while others are using white gasoline. The driving patterns include speeding up and slowing down, cruising, and idling. The cars will go uphill and downhill for specified periods of time, as well as following a course on the level road.

At the end of each 1000 miles, exhaust gases will be analyzed to determine if the catalytic converters are functioning properly. Also, engines will be examined at regular intervals to determine the effect of the unit on operating characteristics of the car and maintenance.

Each car is being driven two eight-hour shifts per day, for a total of approximately 330 miles a day. The current tests are part of the Foundation's expanded research program for 1955 to learn the causes of smog.

Welding Techniques

MILLIONS of dollars could be saved annually by industry through more accurate scientific welding techniques, according to a statement made by William Spraragen, director of the Welding Research Council, at the first annual Midwest Welding Conference at Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

Although practically every good welding engineer could successfully solve a particular problem in the techniques of welding . . . there might be a better way of reaching the same solution, he stated.

In addition to welding-technique problems, he listed four other typical, but diverse, problems, the solutions to which are needed urgently:

1 Brittle fractures which occur in connection with weldments (units formed by welding pieces together) or riveted structures. Ships, bridges, pressure vessels, and storage tanks sometimes develop fractures and fail for reasons that are not always apparent.

2 Problems concerned with code requirements that specify elongation values for high-strength steels and nonferrous materials.

3 Reinforced openings, such as hatches in ships or in pressure vessels and storage tanks.

4 Aircraft problems having to do with the development of welding electrodes, multiple-pass welding, evaluation of fusion weldability of available high-strength aluminum alloys, nondestructive inspection methods of flash welds, and others.

Mr. Spraragen told the welding engineers that combinations of temperatures and pressures have been obtained in the pressure-vessel, boiler, and piping fields that were "undreamed of 20 or 30 years ago."

Such combinations have resulted in greater efficiency of process and have created new industries. It is natural, he added, that such far-reaching changes raised important problems.

The research-council director called for closer teamwork among scientific talent in educating engineers and writing codes. Such co-operation, he said, would reduce the time lag between laboratory developments and utilization of the results in the field.

All-Silicone-Rubber Motor Insulation

THE first all-silicone-rubber insulating system for large motors and generators has been announced by Allis-Chalmers Manufacturing Company. Known as the Silco-Flex system, it is immediately available for all Class H insulated form-wound coils and for Class A and B windings operating under certain service conditions.

The development marks a major step in insulation progress and is expected to change motor-application practice in many industries. It also brings insulation engineers closer to the goal of the "perfect" insulation—one that would never deteriorate or change in dielectric or mechanical qualities, regardless of load, during the entire life of the machine.

Using as its basic material Dow-Corning's Silastic silicone rubber, Silco-Flex insulation makes available the outstanding advantages known to be inherent in silicone-base insulations.

In the manufacture of Silco-Flex insulated stator coils, silicone rubber is applied to conductors, and vulcanized into a homogeneous mass by the applications of carefully controlled heat and pressure. The result is a sealed, impervious dielectric barrier, continuous around the coil and leads, which forms a flexible, moisture and heat-resistant wall over the entire coil structure. This is in contrast to conventional high-temperature insulating systems built up of various combinations of mica, glass, and binders.

The new insulating system is said to offer the following advantages in performance:

Heat Resistance. The excellent dielectric and mechanical properties of silicone rubber do not change significantly with aging at high temperature over long periods of time, even up to 250 C.

Moisture Resistance. Completely sealed Silco-Flex insulated coils are the most moist-resistant commercial

coils ever produced. Even under the most extreme conditions, water absorption is insignificant, with little or no effect on dielectric properties. Surface resistance remains high under moisture-condensing conditions that cause many insulations to flash over.

Abrasion Resistance. Coils insulated with silicone rubber resist abrasive dusts far better than other conventionally insulated coils.

Flexibility and Resilience. Flexible and resilient Silco-Flex insulation is especially capable of withstanding mechanical abuse and the stresses brought about by overloading and rapid starting or stopping of the equipment.

Chemical Inertness. Silco-Flex insulation has outstanding resistance to most atmospheric contaminants, corona, and weathering. It also withstands weak acids, alkalies, and lubricating oils.

Improved Heat Dissipation. Cooler operating windings result from the high thermal conductivity of silicone rubber. In contrast, most electrical insulators are good thermal insulators as well and impede the flow of heat.

As a result of the availability of silicone-rubber insulation, motor-application practice is expected to change in a number of industries. In power-plant induced-draft-fan motors, for example, the highly abrasive cinder and fly-ash contaminated atmosphere will have little effect on Silco-Flex insulated windings. Similarly, abrasive dusts in steel-mill installations will not deteriorate motors protected with the new insulation.

Some applications that formerly required totally enclosed frames may now be handled with semiprotected or open-type frames. This same trend away from the extensive use of totally enclosed frames may be expected in many applications in the chemical, paper, food, and other industries where the moisture-impervious and corrosion-resisting qualities of Silco-Flex insulations can be exploited.

Motors in cement, crushing, and similar industries will retain overload capacities even where ventilation has been inadvertently reduced by heavy accumulation of dusts in the ventilating passages.

Large machines in the 2300 and 4000-volt insulation class, wound with Silco-Flex insulation, are being built. Higher-voltage windings will be available soon. The insulation will be priced on the same basis as previous Class H installations. Engineers expect that as new production techniques can be worked out, the advantages of silicone rubber can be applied to an even wider range of motor types and ratings.

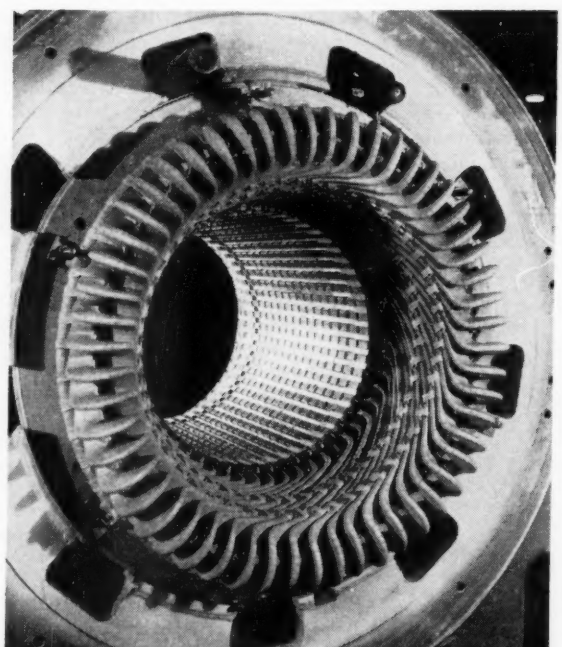


Fig. 17 Stator for 2500-hp, 2300-volt, 3580-rpm squirrel-cage induction motor wound with Silco-Flex all-silicone-rubber insulation. This motor will operate under extreme moisture conditions.

High-Power Transistor

THE tiny transistor of electronic fame has virtually stepped into high-powered company today and is moving up to do a big job for the Army.

These facts were disclosed at the Signal Corps Engineering Laboratories, Fort Monmouth, N. J., with a series of tests on transistors developed under Signal Corps sponsorship and built by the Transistor Products, Inc., a Clevite Corporation plant located in Waltham, Mass.

In one of the tests, the hum in an automobile radio, normally heard when the instrument is first turned on and warming up, was eliminated by using one of the newly developed transistors in place of a vibrator which changes the current from a 6 or 12-volt battery into the 250-volts needed by the radio tubes.

What this implied to the engineers at the Signal Corps Laboratory was of great importance, for it indicated that moving parts may be replaced by transistors in the electronic systems of guided missiles and radar-controlled beacons where moving parts are, at present, a serious problem.

Transistors already have been used to replace low-powered radio tubes in many instances. These devices do their work when an electronic impulse is passed through its layers of crystal, similar to those found in the early radio.

In this case the powered transistor is described as using anything over five watts.

Moving parts in many electronic instruments cause serious problems which may be eliminated with the transistor. Sparks and electrical activity generate an unwanted noise in radios, and reduction of this "hash" ups costs with required extra filters and shielding.

The maintenance of small dynamotors and vibrators in electronic devices is also a problem. The motors must be taken down to replace brushes and worn-out bearings. Constant work and break shortens the life of vibrator devices.

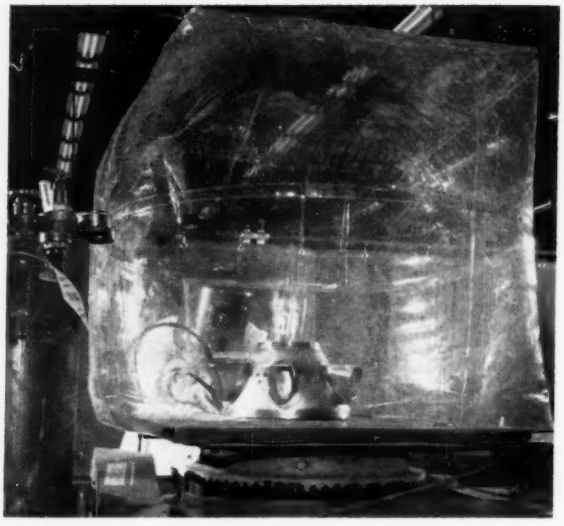
The tiny transistor, smaller than a peanut, has nothing that will move, and its future has engineers intrigued with the possibility of replacing moving parts with stationary fixtures.

Other applications for these transistors may be possible in jeep radios, in tanks and aircraft, fire-control mechanisms co-ordinating radar in guns, and a portable electric megaphone which weighs less than a pound and draws current only when in use.

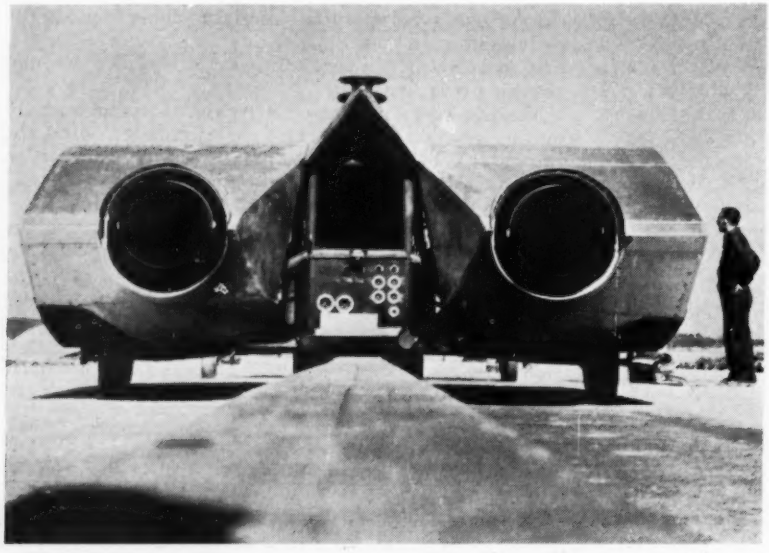
Engineering Developments

. . . at a glance

Precision Optical Processing Center. An optical technician at Northrop Aircraft's Anaheim, Calif., Division, watches closely the operation of a multiple-spindle grinding machine in the firm's new glass-processing center. Several of these many-armed devices, each capable of performing a variety of optical finishing operations simultaneously, are the backbone of the facility, which is the first of its kind on the west coast. Tolerances measured in millionths of an inch are maintained in the production of high-precision optics for several national defense projects currently under way at the Northrop-Anaheim plant.

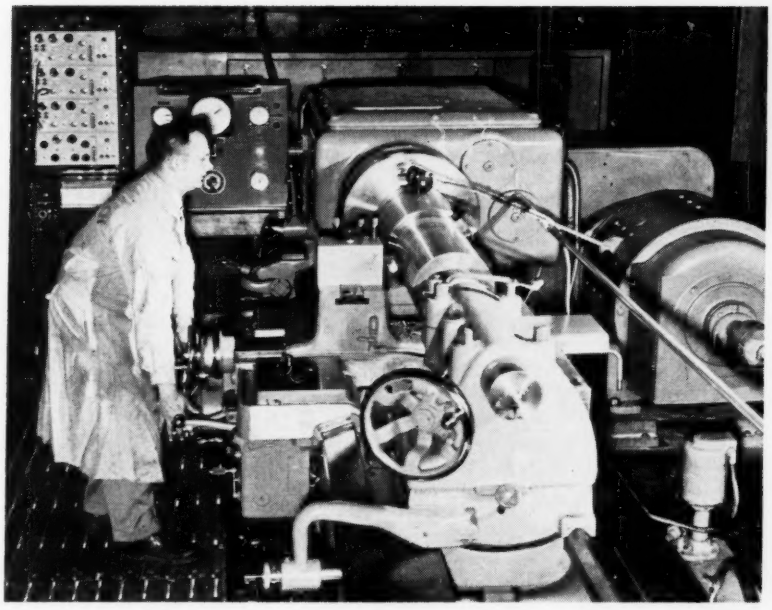


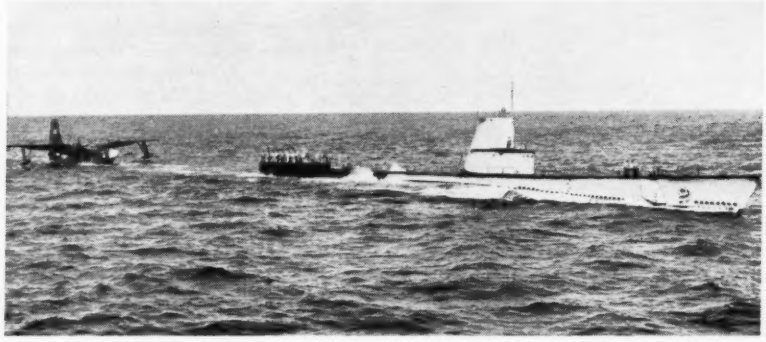
Fusion Welding of Titanium. An ingenious technique for the fusion welding of titanium has been developed at the Des Moines, Iowa, plant of Solar Aircraft Company. In a molten state titanium absorbs many gases—such as oxygen, nitrogen, and hydrogen—that tend to make welds in the metal brittle. Therefore fusion welding of titanium is usually done in a "controlled atmosphere"—by keeping air away from the weld, and by bathing the work with an inert gas. In welding sizable titanium aircraft components at Solar, it was found desirable to make a gas-tight zippered plastic tent (shown in the photo above). The tent is fastened to a standard welding table. The operator wears long-sleeved rubber gloves, sealed to the vinyl bag, to gain freedom of movement.



Jet-Powered Test Car. A jet-powered test car is being used in the development of large-capacity airplane arresting gear by All American Engineering Company of Wilmington, Del. The jet car is powered by two Allison J33-A8 engines of 10,000 lb combined thrust. Supported by standard airplane wheels, the car is held captive to a 5000-ft concrete track at All American's test base at Sussex County Airport, Georgetown, Del. In operation, the car, guided by a structural I-beam, drives a dead load in front of it at speeds comparable to aircraft landing speeds. As the jet car and the dead load approach the arresting gear, the car is braked by a widened section of I-beam. The dead load, simulating a landing airplane, continues into the arresting gear being tested. The development of aircraft arresting gear has taken on new importance since the advent of high-speed jet planes.

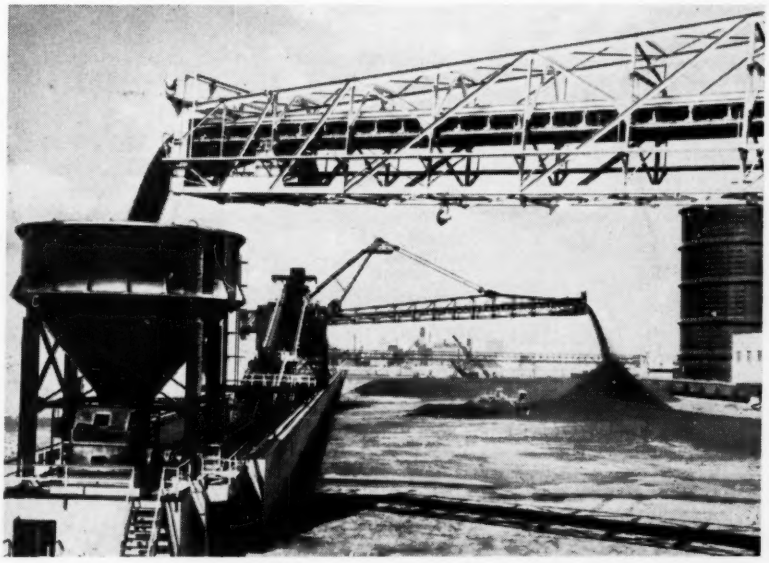
High-Speed Lathe. Heavy cuts at high speeds are no problem with this specially built 125-hp, 32-in. LeBlond lathe installed recently in the machinability lab of Carboloy Department of General Electric Company, Detroit, Mich., for widening the scope of cutting research. The lathe will be used to test materials machinability with various grades of cemented-carbide tools, determine carbide life under all conditions, and provide more information on speeds and feeds in machining with carbide. The 12-ton machine transmits horsepower either through gearing or belting—75 to 100 hp at the spindle through the former, and 100 to 140 hp with the latter. Infinite variable speeds from 4 to 1400 rpm are obtained through a 125-hp variable-speed unit. Speed is maintained by electronic feedback systems with less than 1 per cent variation when a full load is applied. The drive unit can deliver 200 hp for long periods, will supply up to 350 hp before quitting.





Submarine-Seaplane Refueling. In this recent exercise in the Caribbean, the U. S. Navy tested an important new element of its mobile striking power—refueling a seaplane in the open sea from a moving submarine. The two-week operation conducted by Commander Submarine Force Atlantic Fleet involved a twin-engine P5M Martin Marlin patrol seaplane from a Navy squadron based at Norfolk, Va., and the submarine-oiler, USS *Guavina*.

Coal-Stacking-Conveyer System. Coal-handling time has been cut materially by the installation of this mammoth new stacking-conveyer system, linking up a ship-to-shore unloading operation for the Great Lakes Steel Corporation. The new traveling stacker was designed and built by Hewitt-Robins, Inc., for the Great Lakes' blast-furnace-plant operation at Zug Island. It receives coal from self-loading boats at the rate of 2500 tons an hour, compared with 600 tons per hour from the previous installation. Limestone can also be brought in and piled at the rate of 4500 tons an hour. The coal or limestone is discharged from the self-unloader boat boom conveyer into a large hopper which funnels the material to a 72-in. belt feeder. From the feeder the material is discharged into a 60-in. trunkline conveyer and tripped to the tail end of the stacker at any point in its 1200-ft traverse.



European Survey

Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] Mem. ASME ***European Correspondent***

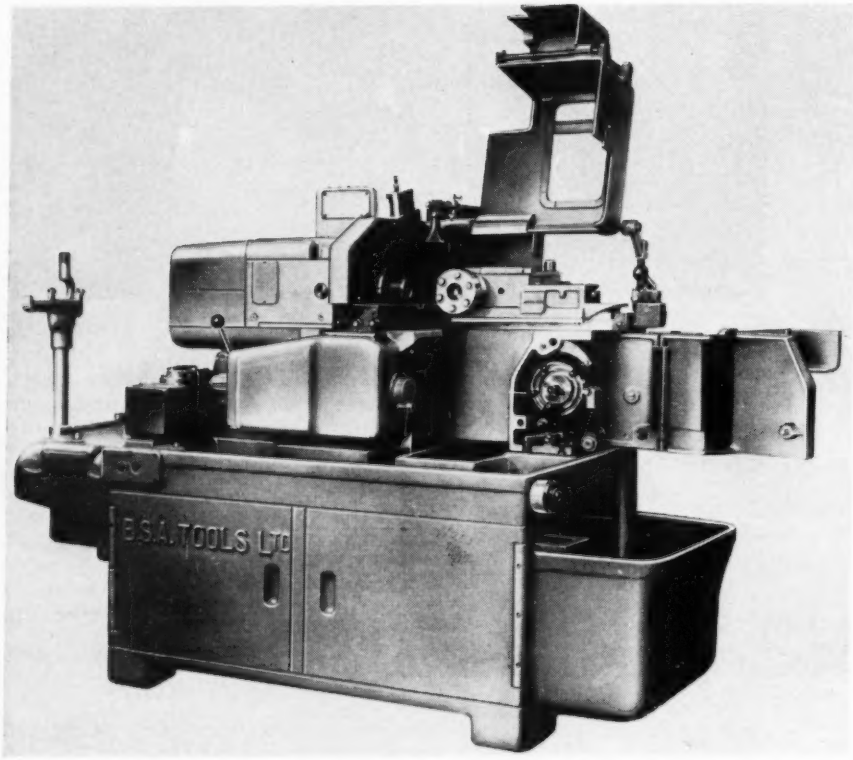


Fig. 1 Front view of the 18L single-spindle automatic screw machine showing how maximum accessibility is achieved despite the neat enclosure of all mechanisms

Single-Spindle Automatic Screw Machine

For some years BSA Tools, Limited, Mackadown Lane, Kitts Green, Birmingham 33, England, have made a range of automatic screwing machines, which is known as the "L" type, the body being in the form of a letter L, giving a completely open front and maximum accessibility. To this range they have added recently a new model, the 18L, Fig. 1, which is built to metric specifications and will take round bar stock up to 18 mm diam. The base is a one-piece casting and contains the spindle-drive gearbox, the coolant tank, and a large swarf pan. There is direct access through covers to the oil tank and filters, and swarf can be removed from the right-hand end while the machine is in operation without disturbing the splash guards.

The chain-driven work spindle is mounted in adjustable taper-roller bearings at the front and cylindrical rollers at the rear. The front bearings are adjusted by means of a worm-driven nut, and the one adjustment compensates for both end play and journal wear. The collet-operating mechanism employs swinging levers instead of the usual collet-tube thrust pads, with a consequent reduction in friction. The clutches are set to a predetermined torque value, so that their final engagement is independent of the sliding movement and is constant at all temperatures; thus the machine can be brought quickly into full production after starting from cold. The speed range of the spindle is from 40 to 4500 rpm. All the important bearings are lubricated by a power-operated Tecalemit "Bijur" pump, which automatically delivers the correct quantity of oil through an individual metering valve at each lubrication point.

The standard gearbox gives two speeds, either forward and reverse or both in the same direction; but a four-speed gearbox is available if required. The backshaft is driven at a constant speed and carries the clutches for feeding the stock, indexing the turret, and changing the spindle speeds. All clutch-locating plungers operate directly on to the final driven member, thus avoiding backlash and insuring, in the case of the turret, that the connecting rod is horizontal after each indexing movement, so that components are consistently produced to the exact length required. Power is transmitted from the backshaft through the cycle-time gears to two worm-reduction gears, driving the turret camshaft and the front camshaft. The cycle time is varied by changing the cycle-time gears in the camshaft gearbox, which is of the constant-center type and totally enclosed, the gears running in oil. The gears are connected to the camshaft through an adjustable-load ratchet which auto-

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matically disengages the main camshaft clutch if, for any reason, the machine is overloaded. The worm drives have independent adjustments for mesh and end play. A feature of the design is that the backshaft clutches engage at precisely the same instant in each cycle, to insure consistent accuracy in operations involving fine clearances, such as tapping a blind hole or working up to a shoulder.

The six-tool turret head is mounted in a taper-bearing sleeve. It is indexed by the usual crank and Geneva mechanism, and is positively located after each indexing. The turret can also be quickly advanced and withdrawn without indexing and remains positively located while this is done; this movement can be effected at any point in the cycle. Provision is made for double indexing, and a threading-die-head closing rod is mounted on the turret body. An opening device for die heads of the Namco type enables them to be controlled accurately for thread length without having to arrange a contact for the usual projecting stop rod. The turret bearings are lubricated by a separate Tecalemit hand pump, to avoid the difficulty of maintaining a satisfactory connection with the main lubrication system. The standard stroke of the turret is 50 mm, but this can be increased readily to 70 mm if required, by changing the rack and segment, the cam carrier, and the turret trip drum.

The cross slides are actuated by a method which eliminates toothed gearing entirely; the front slide is operated from its cam by a single lever, and the rear slide through the cam-lever push rod and the reverse-motion lever at the back of the machine. The slides are supported close up to the cutting position, the under slideways being protected by hinged covers mounted on the cross slides. The single top slide (which can be dismounted by removing two nuts only) is fitted with a micrometer adjustment parallel to the work axis for cutting-off operations, and a fine screw adjustment for tool centering for either right-hand or left-hand cutting. If desired, double top slides can be fitted in place of the single slide; they form a single unit, complete with camshaft, which is driven by a vertical shaft from the main wormshaft of the machine. The toolholders on the two slides are interchangeable; one is made to suit a standard cut-off tool 10 × 4 × 120 mm, and the other a square tool, 10 × 10 × 120 mm. Each has an independent longitudinal adjustment. The driving motor for the machine is mounted externally at the end of the body and is controlled by remote push button. The switchgear is enclosed in a compartment at the back of the base. All operating mechanisms are completely enclosed, but all are quickly accessible. An extensive range of special attachments has been designed to increase the utility of the machine.

Transporter for Ships' Propellers

A SHIP's propeller of large size is one of the most awkward loads that a road haulage contractor has to tackle because of the overhang on both sides of the vehicle when, as is usually necessary, the propeller had to be laid horizontally on it. It is seldom possible to convey a propeller mounted vertically, except in the smaller sizes, as the over-all height would be too great to pass under most bridges. To overcome these difficulties, the Lips Propeller Works, of Drunen, Netherlands, has designed its own special transporter, Fig. 2, on which the propeller is carried on a transverse cradle, resting on rollers and capable of being tilted so as to reduce the width of the load to the minimum. A central column on the cradle, projecting upward through the boss of the propeller, forms the attachment for the securing cover which holds the load in place. When loading, the cradle is set with its upper surface horizontal and the propeller is lowered on to it and secured in place. The cradle is then tilted to bring the blades on the near side of the vehicle close in to the chassis. If, on the road, the transporter comes to a low bridge, the cradle can be quickly swung back to the horizontal position and tilted again when the bridge has been passed. The cradle is so designed that the propeller is turned about its own approximate center of gravity so that adjustment is easy. The tilting action is effected by an electric motor, controlled by push buttons mounted at the rear of the trailer. The total weight of the truck and trailer is 16,000 kg (35,000 lb) and the maximum load that can be carried is 25 tons.

Fig. 2 Special transporter for hauling a ship's propeller. The propeller is carried on a transverse cradle, resting on rollers and capable of being tilted to reduce the width of load to a minimum.

ASME Technical Digest

Substance in Brief of Papers Presented at ASME Meetings

Instruments and Regulators

Characteristics of Slack Diaphragms, by A. S. Iberall, Mem. ASME, Cleveland, Ohio. 1954 ASME Annual Meeting paper No. **54—A-195** (multilithographed; available to Oct. 1, 1955).

THE Foppl-von Kármán theory for the large deflection of thin plates is utilized to classify thin plates into régimes in regard to the type and initial sensitivity of the pressure-deflection characteristics that result from various amounts of initial edge displacement. In the large-deflection régime that arises when the plate is initially buckled (such plates are referred to as slack diaphragms), the force-pressure-deflection characteristics of circular plates are then investigated under two different sets of boundary conditions of instrument interest.

In the first, a pressure-loaded slack diaphragm is additionally loaded by an opposing force applied through a larger rigid disk pressed partially into contact with the diaphragm.

In the second, a pressure-loaded slack diaphragm is additionally loaded by an opposing force applied through a smaller disk rigidly cemented to the diaphragm.

Solutions to these problems are sought, mathematically, in the domain of integro-differential equations, and are presented in graphical form of generalized force-pressure deflection.

An Experimental Study of Two-Dimensional Gas Flow Through Valve-Type Orifices, by A. H. Stenning, Massachusetts Institute of Technology, Cambridge, Mass. 1954 ASME Annual Meeting paper No. **54—A-45** (multilithographed; available to Oct. 1, 1955).

WITH the use of a glass-sided model, an experimental study on air flow through slide-valve orifices has been made with pressure ratios (downstream to upstream) across the orifice in the range 0.95 to 0.2.

Two-flow régimes have been found, one with the fluid leaving the orifice as a free jet and another with the flow attached to the bounding wall of the downstream chamber. Both of these flows are obtainable when pressure ratios are greater than 0.3, but the free-jet flow pattern becomes unstable at pressure ratios lower than 0.3 and transition to the adhering flow occurs. Measurements of orifice-discharge coefficients and of flow angles have been made for sharp-cornered orifices with varying radial clearance.

A Method of Estimating Dynamic Characteristics of Physical Systems, by Sydney Lees, Massachusetts Institute of Technology, Cambridge, Mass. 1954 ASME Annual Meeting paper No. **54—A-69** (multilithographed; available to Oct. 1, 1955).

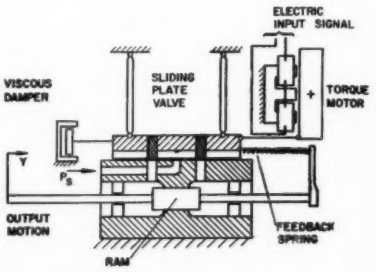
SYSTEM dynamic characteristics are equated to characteristic equation roots by relating the roots to the stability and the form of transient responses. By choosing appropriate standard contours on the root-complex plane, the mapping theorem may be used to estimate the dynamic characteristics of a given system with minimum calculation.

Two examples are presented: One for a polynomial with constant coefficients and the other for one with adjustable coefficients.

Development of a Miniature Electrohydraulic Actuator, by S. Y. Lee and J. L. Shearer, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1954 ASME Annual Meeting paper No. **54—A-196** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

A QUALITATIVE discussion is given of the factors establishing the need for a compact electrohydraulic actuator to operate at a relatively low input-power level and capable of providing an output motion proportional to the magnitude of an electric input signal. Basic requirements of such an actuator are discussed, and the design of each of its components including torque motor, valve, ram, and feedback mechanism, are described in detail.

Results of a dynamic analysis of the complete system are employed to show how adequate system damping is provided, and to show how theoretical speed of response is obtained. Results of steady-state and dynamic tests are compared with the results of the analytical work.



Schematic diagram of miniature electrohydraulic actuator. A small 4-way control valve with a hole-slot-and-plug construction is used to modulate the flow of hydraulic fluid from a constant-pressure source to the chambers of a double-acting ram which delivers the power required to produce output motion. The control valve moves in response to various forces acting on it, consisting of the electromagnetic force generated by the flow of electric current (input signal) through the torque-motor coils and the force exerted by the feedback spring, the lower end of which is attached to ram.

This actuator has been found to fulfill the needs of a number of instrumentation and control applications, and preliminary tests using compressed air instead of hydraulic oil indicate that pneumatic operation of such a device is also feasible.

Predictor Control Optimalizes Control-System Performance, by L. M. Silva, Beckman Instruments, Inc., Fullerton, Calif. 1954 ASME Annual Meeting paper No. **54—A-132** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

A NEW technique for the design of automatic control systems with nearly optimum transient response has been developed. The fundamental concept in the new method is that the control or forcing of the output member must be performed in such a manner that the error or deviation and its derivatives should be reduced to zero in three steps for third and higher-order systems. These three steps consist of a single period of maximum corrective action which forces the controlled variable in the direction of decreasing error or devia-

tion, a single period of maximum corrective action in the opposite sense to decelerate the controlled variable, and finally a force-free period at the end of which the error and its derivatives simultaneously go to zero. In the practical embodiment of this mode of control a proportional-control action exists during the final phase. During this proportional-control period, the controller corrects any errors introduced by the instrumentation during the initial phases.

In addition to the superior transient performance, a predictor-control system has the advantage that its response is not affected by variations in gain, if the gain is sufficiently large, and that the allowable gain in the proportional region is considerably in excess of that permitted in conventional linear-type systems. As a result, the steady-state accuracy which can be obtained is not dependent on a critical gain setting and the system response and accuracy are not degraded by the incorporation of variable gain elements.

Ambient-Temperature Errors in a Gas-Filled Thermal System for Pneumatic-Balance Instruments, by K. H. Stokes and R. C. Whitehead, Jr., Mem. ASME, Minneapolis-Honeywell Regulator Company, Philadelphia, Pa. 1954 ASME Annual Meeting paper No. **54—A-159** (multilithographed; available to Oct. 1, 1955).

THE theory of the gas-filled thermometer is reviewed with emphasis on a gas system in which no change in volume takes place with a change in system pressure. A theory for ambient-temperature errors in this type of system has been developed showing the relation between these errors and such factors as range, volume ratios, and filling pressure. Means of compensating these errors are discussed. Experimental evidence is given to verify both the theoretical errors and the effectiveness of compensation.

Backlash Considerations in Gear-Train Design, by D. D. Acker, Mem. ASME, and A. H. Maschmeyer, North American Aviation, Inc., Downey, Calif. 1954 ASME Annual Meeting paper No. **54—A-111** (multilithographed; available to Oct. 1, 1955).

THIS paper formulates a method for determining backlash in precision gear trains. Contributions of idler gears, of electromechanical components—motors, synchros, potentiometers, and the like—of adapters, and of temperature to backlash in a mechanism are discussed.

A method for calculating backlash when a gear train contains a differential is included.

Finally, suggestions are offered to aid the engineer in designing a gear train to meet stipulated specifications.

A New Type of Flowmeter for Compressible Fluids, by F. D. Ezekiel, Massachusetts Institute of Technology, Cambridge, Mass. 1954 ASME Annual Meeting paper No. **54—A-149** (multilithographed; available to Oct. 1, 1955).

THE theoretical basis is developed for a simple, new type of pressure-compensated orifice flowmeter that measures the

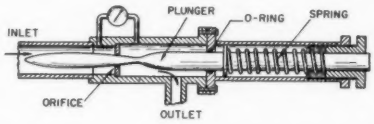


Diagram of a pressure-compensated flowmeter. The plunger is exposed to fluid pressure on one side and to atmospheric pressure on the other. As the fluid pressure increases, the plunger is driven in, and the orifice area is reduced automatically because of specially designed contours on the plunger section moving inside the circular orifice. When the force on the plunger arising from the fluid pressure is balanced exactly by the linear spring, the motion of the plunger is proportional to the fluid-gage pressure.

weight rate of flow of a compressible fluid in the presence of a varying upstream pressure. An experimental model tested at pressures ranging between 200 and 1200 psi indicated flow measurements accurate within a 6 per cent error margin.

A method of simultaneously achieving temperature and pressure compensation is also discussed.

Gas Turbine Power

Modified Residual Fuel for Gas Turbines, by B. O. Buckland, Mem. ASME, and D. G. Sanders, Assoc. Mem. ASME, General Electric Company, Schenectady, N. Y. 1954 ASME Annual Meeting paper No. **54—A-246** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

SODIUM in gas-turbine fuel causes rapid deposit formation as well as corrosion. Besides naturally contained sodium, seawater contamination during transportation introduces additional amounts. In order to obtain the benefits of a low-sodium fuel, 90 per cent or more of the sodium is washed out of the fuel by a scheme described. Results of the desalting show that calcium can be substantially reduced also.

Turbine tests of 50 to 1500 hr duration using these desalted fuels show that deposit can be almost eliminated by keeping both the sodium and the calcium below ten parts per million. The steady-stage decrease in turbine efficiency, resulting from burning these low-sodium low-calcium fuels, is shown to be about 2 per cent and the reduction in regenerator effectiveness about five points.

A specification is proposed, defining a fuel which can be obtained at the point of use by means of the desalting method described and by adding a water solution of magnesium sulphate to the fuel just before it is burned.

Treating vanadium-containing fuels with calcium or magnesium shows that, below 1650 F, magnesium is a better inhibitor than calcium, and since magnesium does not cause deposit, it is used.

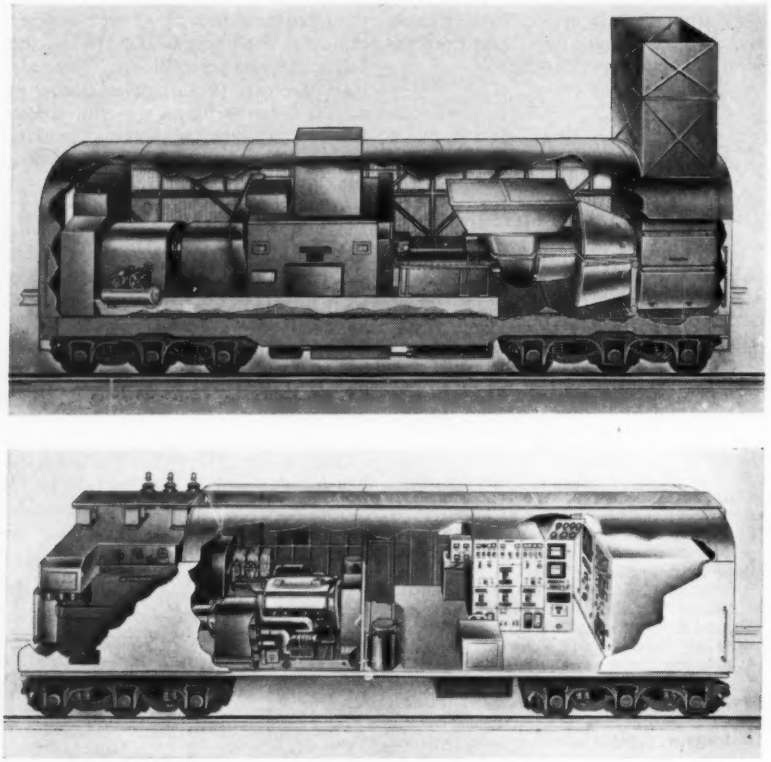
Lead in the fuel in sufficient quantities is shown to spoil, somewhat, the inhibition of vanadium by means of magnesium.

There now appear to be at least two methods available for modifying residual fuel to make it suitable for long-life gas turbines.

The Evaluation of Corrosion Resistance for Gas-Turbine-Blade Materials, by W. E. Young, A. E. Hershey, Mem. ASME, Westinghouse Electric Corporation, East Pittsburgh, Pa., and C. E. Hussey, Jr., Assoc. Mem. ASME, Westinghouse Electric Corporation, South Philadelphia, Pa. 1954 ASME Annual Meeting paper No. **54—A-215** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

THIS paper describes apparatus and test methods which were developed to aid in the investigation of the corrosion associated with combustion of residual fuel oils in gas turbines.

Surface analysis of gas-turbine-blade material, before and after exposure, to the combustion products of residual fuel oils, demonstrates the corrosive effect of these products, and a measurable indication may be obtained in a fraction of the testing time required to produce appreciable weight loss. Surface analysis has the further advantage that it is possible to measure corrosion in specific regions on a specimen where the specimen has been exposed to a gas-flow pattern with a well-defined temperature profile. Weight-loss measurements following long-time tests have shown good agreement with this method of analysis. The fusion temperature of the fuel ash appears to be a reliable criterion for judging the potential corrosivity of residual fuel oil, and good correlation has been obtained between ash-fusion temperatures and corrosion, both for untreated oils and oils with additives.



5000-kw railway-mounted gas-turbine power plant. Top view shows general arrangement of equipment on turbine-generator car. General arrangement of equipment on the transformer-control car is shown at bottom.

A 5000-Kw Railway-Mounted Gas-Turbine Power Plant, by C. H. Giroux, Office, Chief of Engineers, Washington, D. C., J. O. Stephens, Mem. ASME, Westinghouse Electric Corporation, Philadelphia, Pa., and R. J. Nolte, Westinghouse Electric Corporation, East Pittsburgh, Pa. 1954 ASME Annual Meeting paper No. 54—A-191 (multilithographed; available to Oct. 1, 1955).

THE Corps of Engineers, recognizing a need for mobile power plants of a larger output than can be obtained with conventional drives, turned to the gas turbine as a solution to this problem. This paper describes the construction of a 5000-kw power plant, mounted on two railway cars, suitable for service throughout most parts of the world.

Components that comprise this railway-mounted power plant are arranged on two 54-ft-long railway cars. The turbine-generator car provides space for the following equipment: A 5000-kw gas turbine-generator unit with exciter; a 150-hp wound-rotor starting motor connected to the turbine-generator unit by means of an Airflex clutch-type coupling; and the turbine auxiliary control panels.

The transformer-control car provides space for the following equipment: A 6250-kva outdoor transformer; a 150-kw diesel-generator unit; a 50-kw diesel-generator unit; a 30-kva transformer; the high-voltage switchboard; the low-voltage switchboard; the remote turbine-control panel; and all auxiliaries such as car-heating boilers, air conditioning, 32-volt battery, and 4-kw axle-driven generator.

The Influence of Some Chemical and Physical Factors on the Formation of Deposits From Residual Fuels, by P. T. Sulzer, Sulzer Brothers, Ltd., Winterthur, Switzerland. 1954 ASME Annual Meeting paper No. 54—A-171 (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

THE oil-ash deposit problem in industrial gas-turbine plants is analyzed from both physical and chemical standpoints. Theory and experiments on the formation of ash during combustion enable important processes in the build-up of deposits to be understood. These are demonstrated by means of practical examples.

Measurements of ash-deposit formation as a function of temperature, pressure, excess air, fuel-ash content, and test duration, are shown graphically and summarized in a formula.

Structural-Design Problems in Gas-Turbine Engines, by P. N. Bright, General Motors Corporation, Indianapolis, Ind. 1954 ASME Annual Meeting paper No. 54—A-152 (multilithographed; available to Oct. 1, 1955).

TURBOJETS and turboprops have similar design problems except for the turboprop reduction gearbox and propeller shafts, and the resulting interconnecting structure required to attach the gearbox rigidly to the power sections. The power sections of the turboprop engine are practically the same as a turbojet engine except for the additional turbine stages required to absorb the power to drive the propellers. Most of the problems discussed in this paper apply to both types of gas-turbine engines. The problems include: Disk-wheel stresses—turbine and compressor; blade retention; external casing stresses; gyroscopic loads and $1 \times P$ moments; bearing supports; split-line flanges; and interconnecting structures.

Development of Pressurizing, Combustion, and Ash-Separation Equipment for a Direct-Fired, Coal-Burning, Gas-Turbine Locomotive, by J. I. Yellott, Mem. ASME, P. R. Broadley, Mem. ASME, W. M. Meyer, Assoc. Mem. ASME, and P. M. Rotzler, Assoc. Mem. ASME, Bituminous Coal Research, Inc., Dunkirk, N. Y. 1954 ASME Annual Meeting paper No. 54—A-201 (mimeographed; available to Oct. 1, 1955).

THIS paper is the third in a series devoted to the work of the Locomotive Development Committee of Bituminous Coal Research Inc. It describes research programs which have led to solutions for three principal problems confronting the Committee in 1945 when the development of the direct-fired, coal-burning, gas-turbine locomotive was undertaken. These problems were: Feeding pulverized coal to a pressurized combustor, burning the coal efficiently under pressure within locomotive space limitations, and removing fly ash from compressed, heated air to the extent needed to prevent blade erosion.

Each problem was analyzed as completely as possible on the basis of information available. Parallel laboratory-scale projects were established at research agencies to attack each problem in several different ways. Many failures were encountered before success was attained even in small-scale work. A number of

attempts were made before solutions were found which were capable of surviving both small-scale and pilot-plant tests. Those solutions have been used during 2600 hr of actual coal-burning, gas-turbine service, first with a Houdry process turbine and later with a 4250-hp Allis-Chalmers locomotive-type turbine.

The first section of the paper evaluates the problem of burning coal in a gas turbine and describes the facilities established by LDC at various research centers. The next three sections deal specifically with each of the three principal problems—pressurization, combustion, and ash separation. The fifth section describes additional work recommended to enable the coal-burning gas turbine to emerge from the test plant and take its place as a practical, reliable prime mover for both stationary and mobile applications.

Gas-Turbine Exhaust-Heat Recovery, by A. A. Hafer, Assoc. Mem. ASME, and W. B. Wilson, Mem. ASME, General Electric Company, Schenectady, N. Y. 1954 ASME Annual Meeting paper No. **54—A-194** (multilithographed; available to Oct. 1, 1955).

THIS paper discusses a number of possible ways of utilizing the energy contained in the gas-turbine exhaust. Such methods as regeneration, feedwater heaters, exhaust-heat-recovery boilers, fuel-fired boilers, stack ejectors, and the exhaust-fired cycle, are considered. The thermodynamic and economic aspects of these various methods of utilizing the exhaust are analyzed.

Data are presented on gas turbines manufactured by General Electric to illustrate actual installations utilizing the gas-turbine-exhaust energy. Curves are included which indicate the quantity of steam which may be generated utilizing the turbine-exhaust energy at various steam conditions.

Experimental Cooling of Radial Flow Turbines, by E. N. Petrick, Curtiss Wright Corporation, Wood Ridge, N. J., and R. D. Smith, Assoc. Mem. ASME, Purdue University, Lafayette, Ind. 1954 ASME Annual Meeting paper No. **54—A-245** (multilithographed; available to Oct. 1, 1955).

AN air-cooled radial-flow gas turbine having an aluminum rotor of 12 in. diam was operated with turbine-inlet-gas temperatures of 960 R to 1060 R; the cooling air was at ambient temperature and flowed over the back face of the turbine rotor. The temperature was measured at 11 positions on the rotor surface and those measurements gave an indication of the effectiveness with which the rotor was cooled. Significant reductions in the temperature of the rotor material were achieved.

Equations are presented for the computation of the surface coefficients of heat transfer from the rotating disk to a forced convective turbulent flow of air for the cases where the air flowed (*a*) perpendicular to the disk, (*b*) parallel to the disk in the radially outward direction, and (*c*) parallel to the disk in the radially inward direction. Experimental heat-transfer data were obtained for speeds of rotation varying from 8800 rpm to 16,300 rpm, disk-surface temperatures from 750 R to 870 R, inlet air temperatures from 510 R to 530 R, cooling-air-flow rates from 0.03 to 0.30 lb per sec, with spacings of 0.062 in. and 0.125 in. between the rotating (turbine) disk and the stationary wall of the flow passage through which the cooling air flowed. Experimental results were correlated by defining a modified Reynolds number, and by including an area parameter which is analogous to the length-over-diameter ratio frequently employed for correlating heat-transfer results in pipe flow.

Operating Experience on General Electric Gas Turbines, by W. B. Moyer, Assoc. Mem. ASME, General Electric Company, Schenectady, N. Y. 1954 ASME Annual Meeting paper No. **54—A-160** (multilithographed; available to Oct. 1, 1955).

THIS paper summarizes the operating experience on 71 General Electric gas turbines while accumulating over 345,000 hr of operation. Operating problems and maintenance on gas turbines are discussed. First-stage nozzle-temperature shock cracks, compressor and turbine fouling, fuel-nozzle fouling, and combustion-liner replacement are being steadily removed from their former status as operating problems to that of acceptable maintenance. Operating experience on each application is discussed to give an over-all picture.

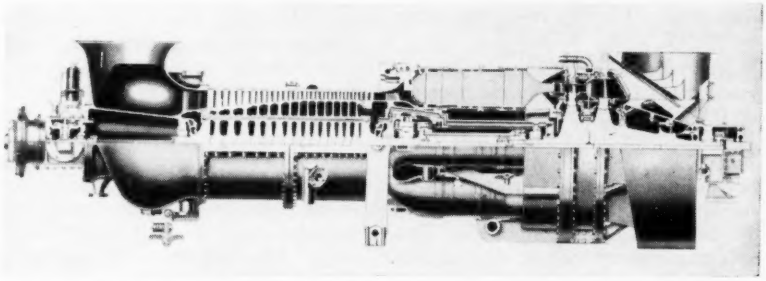
A Method of Aerothermodynamic Design of Multistage Reaction Turbines, by S. L. Soo, Assoc. Mem. ASME, Princeton University, Princeton, N. J. 1954 ASME Annual Meeting paper No. **54—A-208** (multilithographed; available to Oct. 1, 1955).

AN iteration procedure with cascade data was developed to simplify the design analysis of multistage reaction turbines, with special reference to shaft-power gas turbines. A relation expressing stage efficiency in terms of the design values of the ratio of axial velocity to blade velocity, blade-loss coefficient, and isentropic velocity ratio was derived; the optimum isentropic velocity ratio was determined in terms of the other two factors. Significance and possibility of an exhaust diffuser in a gas turbine was analyzed.

Gas-Turbine Bucket-Operating Experience and Bucket and Wheel Design Method, by T. N. Hull, Jr., Mem. ASME, General Electric Company, West Lynn, Mass. 1954 ASME Annual Meeting paper No. **54—A-172** (multilithographed; available to Oct. 1, 1955).

DEVELOPMENT of gas turbines by the General Electric Company has become a reality, with seventy-one as of July 1, 1954, operating in purchasers' plants. The turbine bucket is one of the highest temperature parts under high stress in the gas turbine. This paper gives operating experience, design problems, and preliminary design methods used in the design of gas-turbine buckets. Some of the design considerations associated with gas-turbine buckets are discussed.

A discussion of gas-turbine-bucket material selection with a listing of material properties to be considered in the material selection is included. Operat-



Simple-cycle, single-shaft gas turbine. This gas turbine consists of a 15-stage, 6 to 1 pressure-ratio axial-flow compressor coupled to a two-stage turbine. Present rating of this machine is 5000 kw with a thermal efficiency of 20 per cent at the output shaft connection (based on LHV of fuel).

ing problems discussed include: The high-operating temperature, uneven bucket temperature, vibration impulses which must be considered to design the bucket away from the major resonant conditions, variable speed which increases the possibility of resonant operation, corrosion, and rapid temperature changes, causing thermal stresses. Some convenient curves for the preliminary mechanical design of gas-turbine bucket and wheels are included.

Hydraulics

Cavitation Pitting by Instantaneous Chemical Action From Impacts, by Irving Taylor, The Lummus Company, New York, N. Y. 1954 ASME Annual Meeting paper No. 54—A-109 (multilithographed; available to October 1, 1955).

THE author contends that certain extremely reactive unstable substances are produced locally in water and some other liquids, at the instant of final cavity collapse, by cavitational impacts. These substances complete subsequent chemical reactions in a few millionths of a second. They may react with each other, or with the liquid itself, and disappear by reforming into stable liquid. Those that are very close to a solid wall at the instant of their creation, however, can just as well react chemically with the solid. These reactions occur so quickly that even in a very fast-flowing liquid, the evidence (pitting) may be localized within an inch downstream of the main impact point.

The paper represents an idea rather than new experimental data, the conclusions being stated in the form of contentions. The author, however, presents an analysis of known data upon which these contentions are based.

Management

Quadratic Programming of Interdependent Activities for Optimum Performance, by L. E. Saline, Assoc. Mem. ASME, General Electric Company, Schenectady, N. Y. 1954 ASME Annual Meeting paper No. 54—A-58 (multilithographed; available to Oct. 1, 1955).

STUDIES relating to the performance of economic systems frequently have associated with them problems of programming interdependent activities. Programming interdependent activities is scheduling the levels of operation of the activities to achieve a desired goal and to meet specified requirements. These economic systems may involve the economy of the entire nation or a small part of one business. Commonly it is desired to determine the balance between interdependent activities that gives maximum profit or minimum cost although other measures of effectiveness could be employed.

One method of arriving at a maximum profit or minimum cost (optimum performance) is to cut-and-try until system performance cannot be further improved. A newer method is to use the technique of "programming."

This paper develops and demonstrates a generalized procedure for programming a quadratic function to achieve optimum performance. The method is a generalization of linear-programming techniques which have been used successfully to achieve optimum performance in many economic situations.

Some Observations on Formal Models for Programming, by J. J. Slade, Jr., Rutgers University, New Brunswick, N. J. 1954 ASME Annual Meeting paper No. 54—A-241 (multilithographed; available to Oct. 1, 1955).

A VERY old problem in mathematics is that of finding the values of the components of a multicomponent system at which some designated property of this system attains an optimum value, when the components satisfy certain constraints. Programming, as currently understood, differs from the classical problem only in that the optimum value of the property is sought within a region that satisfies a set of inequalities rather than on a fixed locus represented by a set of equations.

This paper discusses the solution of a programming problem, linear formulation of the problem, saturation phenomenon, and the problem without external constraints.

Petroleum

Design Features in Heat Exchangers, by W. E. Glausser and J. A. Cortright, C. F. Braun & Company, Alhambra, Calif. 1954 ASME Annual Meeting paper No. 54—A-62 (multilithographed; available to Oct. 1, 1955).

MANY people in the process industries work with heat exchangers; for example, plant process engineers, piping designers, purchasing agents, and plant operators. Each is a specialist in his own field. But few of them have an over-all knowledge of the subject. The purpose of this paper is to acquaint these specialists with some of the problems in the design and fabrication of exchangers from the manufacturer's point of view.

The paper does not give formulas or methods for designing heat exchangers, but points out ways in which exchanger users can benefit from the manufacturer's knowledge. It discusses design features of various exchanger types.

This paper is divided into three parts: Heat exchange in general, process design, and mechanical design.

Engineering Considerations in Plant Revamp Work, by John M. Black, The M. W. Kellogg Company, New York, N. Y. 1954 ASME Annual Meeting paper No. 54—A-63 (multilithographed; available to Oct. 1, 1955).

AVAILABLE figures covering the cost of a new plant built from the ground up are apt to be fairly accurate. When it appears that an alternate program of plant adaptation or "Revamp" is possible, then a similarly accurate comparative estimate should be prepared. This paper highlights engineering and construction factors that greatly influence the correctness of "revamp" estimated costs.

It is assumed in the paper that cost data are available covering a completely new comparative plant of the process under consideration. A general approach for assembling a comparative figure covering a "revamp" alternate involves the following steps:

1 Preliminary process study.
2 Round-up of data on existing plant.
3 Detailed process study.
4 Survey of equipment conditions.
5 Obsolescence of machinery and instruments.
6 Survey of auxiliary facilities.
7 Study of land and construction costs.
8 Labor considerations.
9 Cost of shutdown time.
10 Detailing engineering—home office vs. job site.
11 Estimate summary.

Production Engineering

The Application of Linear Programming to Production Engineering and Scheduling, by E. L. Arnoff, Case Institute of Technology, Cleveland, Ohio. 1954 ASME Annual Meeting paper No. 54—A-223 (multilithographed; available to Oct. 1, 1955).

LINEAR programming refers to methods of solving a general class of optimization problems dealing with the interaction of many variables subject to certain restraining conditions. In solving these problems, objectives such as profits, costs, quantities produced, or other measures of effectiveness are to be attained in the best possible, or optimal, fashion subject to certain restraining conditions. These restraining condi-

tions, in turn, may arise from a variety of sources, such as government, marketing, business, production, storage, raw material, or legal restrictions.

Linear programming enables the user to solve a number of production problems. Furthermore, methods of linear programming have been employed successfully to solve a wide variety of other management problems. In particular, the simplex method is especially noteworthy because of its power and flexibility. Not only can it be employed to solve the general linear-programming problem but, with a minimum of effort, new optimal programs can be determined which take into account added restrictions to the problem or changes in the data for the problem. This is very important in that these changes and restrictions can be analyzed in advance and thus provide management with a quantitative basis for answering, among others, questions regarding:

1 Addition of extra shifts;
2 Overtime in one machine center vs. straight time in another;
3 Addition of more machines (additional available time in the machine center);
4 Addition of new machines, special tools or improvement (reduction in unit production rates);
5 Changes in prices to meet a competitive market;
6 Cost (i.e., reduction in profits) due to producing good-will items;
7 Direction of sales effort; and
8 Optimum product mix.

Additionally, linear programming is extremely valuable in that it requires the user systematically to organize, analyze, and evaluate the data in order to arrive at an optimum solution. Finally, it enables the user to readily re-evaluate his solution in terms of added or changing restrictions or other information affecting the general problem.

The Assembly-Line Balancing Problem, by M. E. Salveson, Mem. ASME, General Electric Company, Louisville, Ky. 1954 ASME Annual Meeting paper No. **54—A-222** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

An increasing number of industrial problems in programming and scheduling now are being solved by analytic procedures. Yet, the almost universal problem of balancing an assembly line does not appear heretofore to have been so treated, even though the first known assembly line was established as early as 1776 by Eli Whitney.

Efficient procedures for handling this problem are highly desirable. A very large percentage of all commodities, both civilian and military, are manufactured by assembly-line methods, so that any improvement in these procedures would have a very broad area of impact, in both peacetime and wartime production.

This paper reports initial results of the author's company in attempting to develop such a procedure. While refinements are expected with increasing experience and further research, the practical usefulness of analytic engineering approach to this problem is conclusively demonstrated by present results. Substantial improvements in productivity were achieved in each of several cases in which it was used.

In addition, the present procedure lends itself to machine computation, such that the company expects it will be possible to compute optimum balances for assembly lines for many different levels of output in advance and thereby it will permit the company to reduce by two to three weeks the lead time required to change the rate of production when required by changes in sales.

Inspection Procedures for the Acceptance or Rejection of Incoming Steel Shipments, by D. J. Heinlen, General Motors Corporation, Detroit, Mich. 1954 ASME Annual Meeting paper No. **54—A-209** (multilithographed; available to Oct. 1, 1955).

In the automotive industry the largest single commodity purchased for fabrication purposes is steel. The aim of any plant is to meet its production schedules in the most efficient and profitable manner possible. To accomplish this, it is necessary that production departments be furnished with, among other things, the proper steel to meet the requirements of each particular job. In the process of meeting these schedules, the Detroit Plant of Ternstedt spends millions annually for the procurement of stainless cold-rolled carbon, and hot-rolled carbon strip and sheet steels.

A description is given in this paper of the operation of the steel-inspection department set up to safeguard this investment. Only strip and sheet low-carbon steels, in both coil and cut-length form, i.e., SAE 1008, 1010, and 1020, and AISI stainless type 301 and 430 cold-rolled strip are considered.

The paper covers receiving steel shipments, procurement of steel samples, the steel-inspection laboratory, disposition of rejected steel, and the steel in production.

Interpretation of Ultrasonic Tests Through the Use of Statistical Quality-Control Techniques, by D. F. Flanders, General Motors Corporation, Indianapolis, Ind. 1954 ASME Annual Meeting paper No. **54—A-226** (multilithographed; available to Oct. 1, 1955).

Inspection must be performed 100 per cent on many aircraft-engine components. Ultrasonic testing is one type of inspection that is conducted completely on highly stressed parts such as the impeller and turbine wheel of the jet engine. This sound testing reveals internal flaws that could cause parts to fail. Even though ultrasonic testing is conducted 100 per cent, a statistical quality-control technique, known as the "average and range-control chart," has proved to be valuable in determining the trend of incoming quality.

This paper describes some of the equipment used in ultrasonic testing and the application of the average and range-control chart. It also describes how the control chart reflects approaching trouble. Before explaining the control-chart technique as it is applied to ultrasonic testing, the paper describes briefly the ultrasonic principle.

The Application of Statistics to Simple Fixed-Gage Design, by H. C. Charbonneau, General Motors Institute, Flint, Mich. 1954 ASME Annual Meeting paper No. **54—A-210** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

Using as an example a simple fixed-gage design, the author explains the application of statistics to quality control. The methods of selecting and designing gages are considered—the bilateral and unilateral systems. How these tolerance theories may be applied and the results achieved are discussed at some length.

Rubber and Plastics

Engineering Developments of Rubber, July, 1953–August, 1954, by Lillian Sutter, University of Akron, Akron, Ohio, and Leora E. Straka, Goodyear Tire and Rubber Company, Akron, Ohio. 1954 ASME Annual Meeting paper No. **54—A-256** (multilithographed; available to Oct. 1, 1955).

This paper discusses new products and developments in rubber during the period July, 1953, to August, 1954. Sections of the paper are devoted to conveyer belts, silicones and seals, tires and tire testing, ozone and rubber cracking, compounding and vulcanization, and testing. A $5^1/_2$-page bibliography is included.

Molding Reinforced Plastics With Low-Cost Cores, by W. B. Wilkins, Mem. ASME, Ridgewood, N. J. 1954 ASME Annual Meeting paper No. 54—A-198 (multilithographed; available to Oct. 1, 1955).

THE paper describes a method of manufacturing high-strength articles using common boxmaking techniques for producing low-cost cores, with high-speed machinery. After the core is formed, it is covered with a thin layer of high-strength fibers, usually glass, the resin applied, and the entire preform dropped in the mold.

While this method is still in its infancy, a number of articles already have been produced successfully by this means, and a wide range of potential applications is being explored.

Recognizing Applications for Reinforced Plastic, by R. W. Matlock, Zenith Aircraft, Gardena, Calif. 1954 ASME Annual Meeting paper No. 54—A-199 (multilithographed; available to Oct. 1, 1955).

THE field of reinforced plastics is very new. It is to be expected, therefore, that few engineers are skilled in design with this material, or even sufficiently familiar with its properties or methods of fabrication to judge its merits for a specific design.

This paper discusses briefly the advantages and disadvantages of the material, in general terms, and analyzes a variety of parts which have proved to be successful applications.

A method is proposed by which a layman may judge if the use of reinforced plastic should be given serious consideration.

Plastic-Covered Antennas Reduce Radio Interference, by W. A. Von Wald, Jr., Naval Research Laboratory, Washington, D. C. 1954 ASME Annual Meeting paper No. 54—A-200 (multilithographed; available to Oct. 1, 1955).

THIS paper describes the development of insulated and sealed antennas for aircraft. The use of this type antenna has resulted in substantial reduction in radio interference from precipitation static and improved performance in other respects. The more important technical aspects of these antennas are also presented.

This type of protection to date has been limited to fixed wire antennas on aircraft. The application of the same principle to airfoil antennas or other types of flush antennas also may be feasible. Another application where this type of antenna may be useful is marine radio installations where spray tends to short out open-type antennas. In contemplating future applications of insulation to suppress corona in d-c systems, it should be remembered that the unusually high dielectric strength upon which the useful performance of the insulated antenna depends has not been accounted for. With a more thorough understanding of this effect, other applications also may be developed.

Use of the Repeated Hysteresis Loop for the Evaluation of Reinforced Plastic Materials and Structures, by G. W. Bainton, Jr., General Electric Company, Schenectady, N. Y. 1954 ASME Annual Meeting paper No. 54—A-269 (multilithographed; available to Oct. 1, 1955).

GLASS-FIBER reinforced plastics possess high physical strengths only when the glass fibers assume the load. The degree to which the glass fibers assume the load depends upon a number of factors among which are: Uniform tension of the fibers, the amount of bend produced in the fiber during secondary fabrication, the size of the unit fiber bundles, and the efficiency of wetting of the fiber by the resin.

Because of one or more of these factors, plus the added effects of moisture, only a small fraction of the initial strength of a glass-fiber reinforced-polyester structure can be used as a working load.

Standard strength tests have been used to determine the relative worth of resins and filler structures under various conditions of temperature and humidity and much has been learned about behavior under static load through the use of creep tests.

The purpose of this paper is to show that such data can be supplemented by a study of the hysteresis loops and flexural modulus during repeated cycling of a specimen in flexure. In particular, this paper is concerned with the differences in safe working loads as a function of differences in reinforcing structure, together with the rate and mechanism of failure encountered.

Materials Handling

General Engineering in Grain Bulk Handling, by B. W. Hackstaff, Mem. ASME, The F. & M. Schaefer Brewing Company, Brooklyn, N. Y. 1954 ASME Annual Meeting paper No. 54—A-249 (multilithographed; available to Oct. 1, 1955).

HANDLING of materials efficiently is now a major concern of all industry. Many types of equipment are now available to the engineer in his development of continuous handling systems. The capabilities of each type must be fully understood before over-all efficiency in operations can be obtained. This paper deals with the problems of handling grain in bulk.

The following steps are discussed: Receiving and storing grains, weighing and grinding grains preparatory to cooking, batching, weighing, and combining grains and cooking, and separation of liquid extract from spent grains and removal of spent grains from the process.

In each step various flow conditions have to be met. Receiving grains is intermittent, allowing for a rapid movement to storage. Storage acts as the surge in the system. All other steps are more or less continuous in spite of batch cooking and batch separation. The continuous cycle of handling is subject to large variations in volume due to the seasonal nature of the brewing industry. Peak-season capacity can run as high as twice that of the dull season. Controls and equipment selection play an important part in successful operation.

Other problems include the following:

1 Safety from dust fires and explosions,

2 Ease of cleaning to maintain high standards of sanitation and housekeeping,

3 Lubrication of the various parts in a manner to prevent contamination of grains handled and subsequent loss of foam stability,

4 Erosive quality of the grains handled,

5 Removal of tramp materials,

6 Accurate weighing of materials for Brewery and Alcohol and Tobacco Tax Division records,

7 Control of the system for minimum manpower and maximum safety and continuity, and

8 Simplicity of installation for low maintenance.

Properties of Metals

Carbon-Molybdenum Steel Steam Pipe After 100,000 Hours of Service, by R. J. Sinnott, Mem. ASME, and I. A. Rohrig, The Detroit Edison Company, Detroit, Mich., and J. W. Freeman and A. I. Rush, University of Michigan, Detroit, Mich. 1954 ASME Annual Meeting paper No. 54—A-73 (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

WHEN Unit No. 14 was being erected at the Delray Power Plant of The Detroit Edison Company in 1938, the lack of reliable data on service-life properties of metals subjected to high temperatures was felt acutely. The practice of basing

design on stresses obtained by 1000-hr high-temperature laboratory tests extrapolated to 100,000 or more hours has repeatedly been questioned. Designers accepted such data only because no better method of property prediction of high-temperature characteristics has been available. This paper presents: (*a*) The results of creep measurements made on carbon-molybdenum pipe subjected to 100,000 hr of actual power-plant service, (*b*) results of after-service laboratory testing, and (*c*) a discussion of service results as compared to properties predicted by laboratory testing prior to service.

Remarkable correlation was observed between calculated service creep rates and those established by subsequent laboratory creep testing. Full agreement with average values used by the Subgroup on Allowable Stresses for Ferrous Materials of the ASME Boiler Code Committee in setting allowable stresses for this material was established for both creep and stress-rupture properties.

Investigations Into Blade-Root Fixings of High-Temperature Steels, by W. Siegfried, Sulzer Brothers, Ltd., Winterthur, Switzerland. 1954 ASME Annual Meeting paper No. **54—A-236** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

THE progress in mechanical engineering which has led in the past few years to much lighter designs of aircraft and land vehicles can be attributed to improvements in the materials used and to a much better adaptation of structural design to these materials. In cases where the temperature is low in aircraft and land conveyances, the engineer's main problem has been alternating stresses.

In applications where steels are used at high temperatures similar problems exist, but our knowledge is here less firmly founded than in the domain of alternating stress at room temperature. Test results described, however, point to a similar line of advance as has been followed in automobile and aircraft engineering. Here, too, it is important not only to develop better materials but also to improve designs if the strength properties of these materials are to be fully utilized. An improvement in creep properties at high temperatures can be attained, as a rule, only at the price of an increase in embrittlement and sensitivity to notching. These considerations are particularly important in the attachment of blade roots to turbine disks. A large number of tests have been made with the aim of throwing some light on these problems and obtaining a clearer idea of the basic connection between structural design and strength.

The investigations have comprised long-time tests on smooth and notched specimens and on various models of blade-root fixings. Results of the tests on smooth and notched specimens were explained on the basis of a working hypothesis which conforms to Ludwick's theory of the embrittlement of materials at room temperature. This made it possible to find at least a qualitative explanation of the relationship between materials and embrittlement and to clear up a number of points which hitherto have been rather obscure.

Tests carried out on models of blade-root fixings showed that in assessing the strength of blade fixings it is necessary to take account not only of the results of creep tests on smooth bars but also of embrittlement, which can be investigated only in tests on notched bars. It was also found that the design of the indentations in the blade root plays an important part in deciding the strength of a fixing, and that certain high-temperature metals which are subject to embrittlement can be used only if the indentations are given the most favorable form.

This paper describes the results of the creep tests on the blade-root fixings.

Factors Influencing the Notch Fatigue Strength of N-155 Alloy at Elevated Temperatures, by W. S. Hyler, Assoc. Mem. ASME, and W. F. Simmons, Battelle Memorial Institute, Columbus, Ohio. 1954 ASME Annual Meeting paper No. **54—A-239** (multilithographed; available to Oct. 1, 1955).

DATA have been presented to illustrate the effect of stress raisers on the elevated-temperature fatigue behavior of N-155 alloys. These data were obtained on specimens notched with V-grooves having various root radii and various notch severities. The experimental program was in direct-stress fatigue and covered a range of alternating stress to mean stress from $A = 0.0$ to $A = \infty$ at temperatures of 1200 F to 1500 F. Effect of surface finish also was studied to a limited extent. A metallographic study of fractured surfaces was carried out.

For the range of root radii and notch severity studied, the following conclusions appear warranted on the basis of this investigation:

1 N-155 alloy is notch-strengthened to some extent in fatigue for low-load ratios. The observed strengthening depends upon notch severity, load ratio, temperature, and time. It appears that greater strengthening is associated with larger radii notches, higher temperatures, and longer exposure times.

2 The effect of a notch on the fatigue behavior of N-155 at high load ratios is detrimental. The detrimental effect is influenced particularly by notch severity, stress redistribution, which occurs during the early stages of fatigue, and temperature.

3 Some speculations with regard to the observed behavior of notched N-155 alloy have been made. It appears that a rational explanation of notch-bar strengthening in fatigue may be based on notch geometry, creep or relaxation behavior, and ductility. However, strain hardening and other metallurgical changes induced by cyclic stress also may be important factors. Studies of other materials might provide data upon which assessment of the effects of these factors could be made.

Factors Influencing the Notch-Rupture Strength of Heat-Resistant Alloys at Elevated Temperatures, by R. L. Carlson, R. J. MacDonald, and W. F. Simmons, Battelle Memorial Institute, Columbus, Ohio. 1954 ASME Annual Meeting paper No. **54—A-240** (multilithographed; available to Oct. 1, 1955).

STRESS-RUPTURE tests were conducted on notched and unnotched or plain bars of S-816, Inconel "X" Type 550, and Waspaloy alloys at test temperatures ranging from 1200 F to 1600 F. The notched specimens had 50 per cent, 60-degree, V-notches with the root radii ranging from 0.005 in. to 0.100 in. In some tests as many as three notches of different root radii were used.

Test results indicated that S-816 alloy was notch-strengthened by all of the notches used, in the temperature range from 1350 F to 1600 F. Inconel "X" Type 550 was always notch-strengthened by all of the notches only at the test temperature of 1600 F. Waspaloy was always notch-strengthened by all notches only at the temperature of 1500 F. Both Inconel "X" Type 550 and Waspaloy could be notch-strengthened for some test conditions (notch sharpness and time) at temperatures below 1600 F and 1500 F, respectively.

Factors considered to have an influence on stress-rupture behavior have been studied and the results are included. The factors investigated are notch geometry, notched and unnotched ductility, the modes of deformation and fracture, metallurgical changes, and surface condition. The influence of some of these factors can vary considerably from alloy to alloy. It does not appear possible, therefore, to evaluate completely the

notch and unnotched stress-rupture behavior of a given alloy by any simple method. Rather, an evaluation should be based upon the combined consideration of those factors that are influential in each individual case.

Properties of Cast Iron at Elevated Temperatures, A Progress Report, by J. R. Kattus, Southern Research Institute, Birmingham, Ala. 1954 ASME Annual Meeting paper No. **54—A-162** (multilithographed; available to Oct. 1, 1955).

An evaluation of the properties of cast iron at elevated temperatures is being undertaken at Southern Research Institute under the sponsorship of the Joint ASTM-ASME Committee on the Effects of Temperature on the Properties of Metals. The purpose of this work is to develop fundamental data on the characteristics of cast iron (conforming to ASTM Specification A278 Classes 40, 50, and 60) in the temperature range 700 to 1000 F. The experimental results will be used to determine the load-carrying ability of cast iron for such elevated-temperature applications as valves, drier rolls, pumps, and the like.

Screening tests, stress-rupture and creep tests, and thermal-shock tests, are to be carried out. This report covers a literature survey and screening tests on 12 commercial irons to determine their resistance to softening at elevated temperatures. These tests showed good correlation between alloy content and resistance to softening, but the literature survey showed only partial correlation between creep and stress rupture and other elevated temperature properties. Based upon the results of the literature survey and screening tests, a selection of 8 irons for stress rupture and creep testing was made.

Research Planning Committee

Thermal Conductivity of Gases, by F. G. Keyes, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1954 ASME Annual Meeting paper No. **54—A-235** (multilithographed; available to Oct. 1, 1955).

A previous paper reported data for neon at four temperatures below 0 C and to about the boiling point of oxygen. Data also were tabulated from measurements for argon, hydrogen, nitrous oxide, methane, ammonia, ethane, ethylene, ethyl chloride, Freon 12, and Freon 114 over a range of pressure above 0 C.

During the past year measurements have been largely confined to completing the measurements in the low-temperature range on the following substances: Argon, krypton, xenon, nitrogen, oxygen, carbon dioxide, and methane. Data for these gas measurements were made over a pressure range, and where possible for the liquid phase also. Results are tabulated. Constants for an empirical equation used to correlate thermal-conductivity data are given, and equations for the pressure effects are also given.

Wood Technology

Engineers Need a Hobby, by T. D. Perry, Mem. ASME, Moorestown, N. J. 1954 ASME Annual Meeting paper No. **54—A-177** (multilithographed; available to Oct. 1, 1955). Reported in Mechanical Engineering, January, 1955, p. 66.

Some Home-Workshop Products, by J. A. Fenchen, Hotel Statler, New York, N. Y. 1954 ASME Annual Meeting paper No. **54—A-213** (multilithographed; available to Oct. 1, 1955). Reported in Mechanical Engineering, January, 1955, pp. 66–67.

Power Tools, by R. C. DuBrucq, Rockwell Manufacturing Company, and president, Association of Manufacturers of Woodworking Machinery, Washington, D. C. 1954 ASME Annual Meeting paper No. **54—A-176** (multilithographed; available to Oct. 1, 1955). Reported in Mechanical Engineering, January, 1955, p. 67.

Metal Processing

Shear-Plane Temperature Distribution in Orthogonal Cutting, by J. H. Weiner, Columbia University, New York, N. Y. 1954 ASME Annual Meeting paper No. **54—A-65** (multilithographed; available to Oct. 1, 1955).

The cutting of metals involves large inelastic deformations, most of the energy of these appearing as heat released over the shear plane. Assuming that the rate and distribution of heat release is known, the calculation of shear-plane temperatures is a complex heat-conduction problem involving as it does a moving-band heat source, inclined to its direction of travel, and losing heat both to the workpiece and chip, the latter moving in a direction different than that of the workpiece. It appears that drastic simplifications are required before a mathematical solution may be obtained.

The present analysis avoids the previous simplifications, which it is felt introduce considerable error, at the expense of making a new simplification, which it is hoped does not. The simplification consists in neglecting the transfer of heat by conduction in workpiece and chip in the direction of their respective motions in comparison with the heat transferred by material transport in those directions and the heat conducted in the direction perpendicular to the direction of motion. This assumption results in considerable mathematical simplification, changing the character of the partial differential equations from elliptic to parabolic.

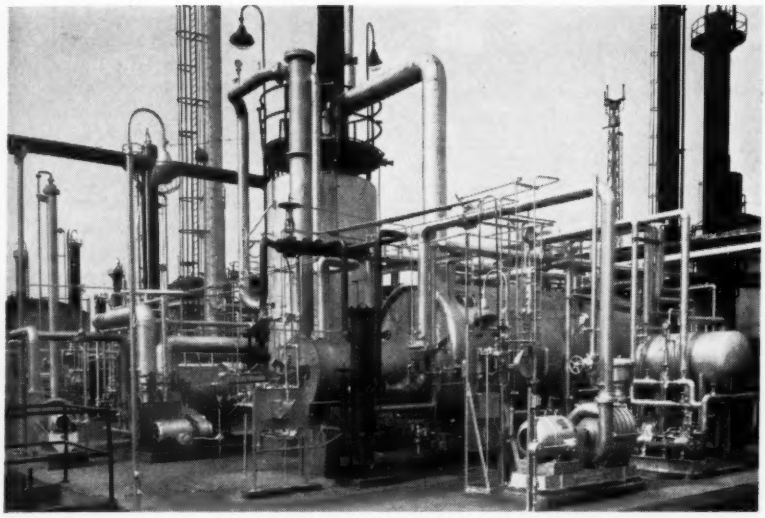
While this assumption is a common and understandable one in the study of heat transfer in a flowing fluid, it seems unusual when the moving medium has the high conductivity of a metal. In order to estimate the magnitude of the error introduced in this manner, the problem of the inclined band source moving through an infinite medium treated by Hahn, and Chao and Trigger, is solved with this assumption, and the solution compared with that which includes the effect of conduction in the direction of motion. This comparison, made in the Appendix to this paper, indicates that for the conditions encountered in practice, the two solutions for this problem agree very well. Since this problem is similar to the metal-cutting process it seems reasonable to hope that there, too, the assumption introduces little error. It is recognized, however, that reasoning by analogy in this manner is sometimes misleading. Rigorous upper bounds on the error introduced by this assumption appear to be difficult to obtain, but would be very valuable, particularly since the same procedure introduces considerable simplification in many other problems involving moving sources.

There are two principal zones of heat generation in orthogonal cutting, zone A, due to friction between tool and chip, and zone B, due to the energy released in the shear deformation. This paper is concerned only with the temperature distribution along the shear plane due to the heat generated in zone B.

Air-Pollution Control

Refinery Sulphur Recovery Aids Air-Pollution Control, by G. E. Smalley and J. W. Klohr, The Ralph M. Parsons Company, Los Angeles, Calif. 1955 ASME International Air Pollution Congress paper No. **55—APC-12** (multilithographed; available to Jan. 1, 1956).

The disposal of hydrogen sulphide released in some present-day refining operations poses a problem to refiners. Many have found that easily operated plants which convert the hydrogen sulphide to elemental sulphur provide a practical and profitable means to handle these streams.



Small sulphur-recovery plant. By the end of 1955 approximately 1000 tons per day of sulphur will be recovered from sour gases at petroleum refineries throughout the United States. Since these refineries are located near population centers, the installation of sulphur-recovery plants provides an important aid to air-pollution control. The recovered sulphur will represent a reduction of 2000 tons per day of sulphur dioxide which otherwise would be released to the atmosphere.

Not only is the quantity of sulphur compounds emitted to the atmosphere reduced, but also an additional supply of a valuable commodity is produced which is expected to be in excess of 1000 tons per day by the end of 1955.

A description of the process and plant operation is given.

The Role of Sulphur in Iron and Steelmaking, by T. P. Colclough, British Iron & Steel Federation, Westminster, England. 1955 ASME International Air Pollution Congress paper No. **55—APC-6** (multilithographed; available to Jan. 1, 1956).

IT IS common knowledge that the presence of sulphur in iron and/or steel, except in certain special conditions, is harmful and rigid limits on the amount permissible are imposed by standard specifications. For ordinary commercial steels the maximum sulphur content is specified as 0.06 per cent, for steels subjected to deep-drawing operations 0.025 per cent, and for certain special qualities even lower limits are imposed. Typical specifications are given in this paper.

It is equally well known that practically all the raw materials—iron ore, limestone, and particularly the fuel used in the manufacture of iron and steel—contain sulphur in varying but marked degree.

This paper examines the quantity of sulphur involved, the effect of the sulphur in the manufacturing processes, the manner in which the sulphur is dealt with and, in particular, the form and quantity of sulphur which is disposed of in gaseous form.

The World Supply of Sulphur, by J. C. Carrington, Freeport Sulphur Company, New York, N. Y. 1955 ASME International Air Pollution Congress paper No. **55—APC-5** (multilithographed; available to Jan. 1, 1956).

SULPHUR, one of the essential materials for industry and agriculture, occurs plentifully. Among its forms are native sulphur, or brimstone; metallic sulphides, principally pyrites; sulphide gases associated with natural gas and petroleum; and natural sulphates. It is produced in some 40 countries of the free world.

Free-world production of sulphur has been increasing as a result of a great deal of activity on many fronts. In 1953 total output of sulphur in all forms, including the sulphur content of sulphur-bearing materials, reached an estimated 12,700,000 long tons. Of this, the Western Hemisphere produced more than half.

Free-world consumption of sulphur in 1953 amounted to an estimated 12,500,000 tons, virtually equivalent to production. The Western Hemisphere consumed less than half of the total, exporting a portion of its production to the Eastern Hemisphere. The sulphur was used for a great variety of industrial and agricultural purposes, the pattern of consumption by a country depending upon the nature of its economy.

The present sulphur supply-demand picture is one of production and productive capacity ample to meet all needs. Additional sulphur-productive capacity is being added. Increasing requirements for sulphur are predicted by the President's Materials Policy Commission. The outlook thus is for continued growth in both supply and demand.

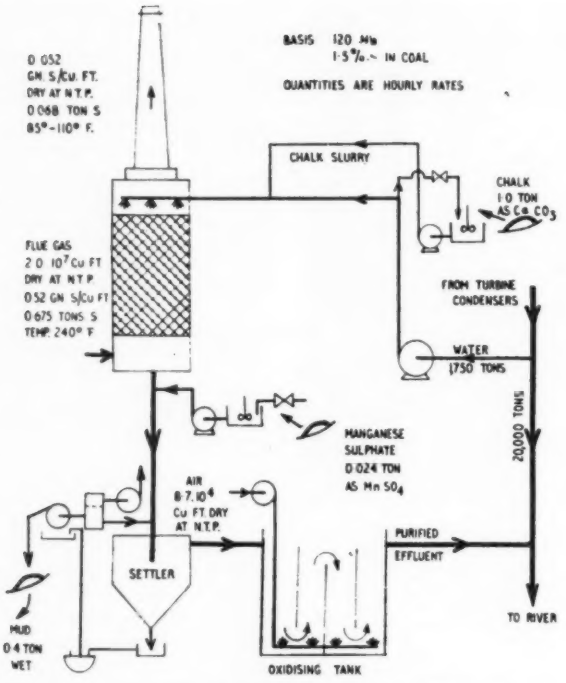
Air-Pollution Control by a Sulphur-Dioxide Scrubbing System, by Clayton Lawler, Olin Mathieson Chemical Corporation, Little Rock, Ark. 1955 ASME International Air Pollution Congress paper No. **55—APC-19** (multilithographed; available to Jan. 1, 1956).

IT IS one thing to develop a method for the elimination of air pollution. It is an entirely different thing to find a method that is economically sound, at least to the extent that it does not make the entire operation a cost burden. It is also important that the method selected does not convert an air-pollution problem into a water-pollution problem which cannot be handled. The author's company believes these criteria have been met successfully with respect to sulphur-dioxide removal in a system installed a little over a year ago in its large sulphuric-acid operation at Pasadena, Texas.

This paper discusses how the system operates, the scrubbing system, the extensive research conducted, and the development of a recovery system.

The Removal of Sulphur Dioxide From Power-Plant Stack Gases, by R. L. Rees, British Electricity Authority, London, England. 1955 ASME International Air Pollution Congress paper No. **55—APC-2** (multilithographed; available to Jan. 1, 1956).

IN SO FAR as is known, the only power stations in the world in which flue gas is washed are in Great Britain, where the Battersea process is in use at the Battersea and Bankside Power Stations in London. Although power plants burn only about one fifth of the total amount of coal consumed in the country and mostly discharge the stack gases into the atmosphere at a much higher level than other consumers, there has been continued interest for many years in the possibility of lowering the concentration of sulphur dioxide in power-plant stack gases. Interest has been intensified by the rate of growth of electricity generation, by the trend toward high concentrations of sulphur in the fuel above the normal average of 1.5 per cent, and by the effects



Typical arrangement of modified Battersea effluent process now in use at Battersea and Bankside power plants in London

of the London fog of December, 1952, which led to the formation of a Committee on Air Poilution who, among many recommendations, included one in favor of removing sulphur from flue gases at new power stations in or near populated areas. The British Electricity Authority has been studying the whole subject since the formation of the Authority in 1948.

The paper discusses the problem of removing sulphur dioxide from power-plant stack gases in Great Britain, reviews the adequacy and cost of available processes, mentions research in progress, and briefly considers the effect of flue-gas washing on air pollution.

Experience With Air Pollution in Holland, by A. J. Ter Linden, Technische Hogeschool Laboratorium voor Warmte en Softechniek, Delft, The Netherlands. 1955 ASME International Air Pollution Congress paper No. **55—APC-7** (multilithographed; available to Jan. 1, 1956).

THE pollution of the air by dust particles and gases leaving the stacks of industrial plants has taken serious aspects in several districts of Holland. Instructions to keep the nuisance within reasonable bounds are necessary. These instructions should not be based on the quantity of dust or gases, leaving the stacks only, but also should take into account the height of the stacks and the sizes of the dust particles. The deposit of dust in the neighborhood of a boiler-house has been calculated approximately, and a formula for this deposit has been derived. Making use of this formula, rules have been issued in Holland by a committee of specialists. Although these rules were not required by law, people have conformed well to these instructions.

Sulphur Dioxide Causing Abiotic Disease in Forest Species, by Natalina Ferreira dos Santos de Azevedo, The Direction General of the Forest Services, The National Agronomic Station, Lisbon, Portugal. 1955 ASME International Air Pollution Congress paper No. **55—APC-14** (multilithographed; available to Jan. 1, 1956).

Two cases are presented of damage to forest stands of maritime pine and blue gum, both occurring in the District of Aveiro, Portugal, caused by pollution of the atmosphere by gases from industrial plants.

The first case was that of a mixed stand of pine and eucalypts, where the latter was the dominant species. In the early stage, red and brown patches outlined by a thickened rim, appeared on the leaves. In the more advanced stages of the attack silver specks and patches developed which ultimately would turn into large corroded areas. The whole leaf would then become dry and deciduous, leaving the trees completely bare. The pines did not undergo such severe injuries.

The second case was that of two pine stands (with a few eucalypts in one of them) in the vicinity of a brick yard, where the wind spread the exhaust gases from an oil engine over a large part of the nearby trees, causing very severe damage, especially to the pines, which presented the aspect of a greatly lowered vitality and the needles of which were very thin and small. A great many were dry or even burnt. Secondary branches, the upper part of the trunks, and the twigs were soft when pressed between the fingers, and could easily be bent without breaking. The trees were covered all over with black soot. The damage in these stands was considerable—a great number of trees had been killed. The pines unquestionably had suffered most, but the eucalypts also presented nearly all the symptomatology described for the first case. The observations in loco, the general aspect of the vegetation, the results of the microscopic and chemical analyses, point to the conclusion that both these cases are due to pollution of the atmosphere by sulphurous gases.

Collective Intoxication in Italy Due to Atmospheric Pollution, by Giovanni Pancheri, Ente Nazionale per la Prevenzione degli Inforuni, Rome, Italy. 1955 ASME International Air Pollution Congress paper No. **55—APC-16** (multilithographed; available to Jan. 1, 1956).

THE author relates the prevailing industrial conditions in Italy which contribute to the air-pollution problem. Several major incidents of mass toxicity are cited, as well as regulations pertaining to control, methods of alleviating conditions of atmospheric pollution, and an appeal for information on equipment and methods developed to reduce this hazard to health and property.

Air-Pollution Control: Needed Engineering Research and Development, by Leslie Silverman, Mem. ASME, Harvard School of Public Health, Boston, Mass. 1955 ASME International Air Pollution Congress paper No. **55—APC-18** (multilithographed; available to Jan. 1, 1956).

PROBLEMS confronting industry in air-pollution control require further engineering research and development. In this paper the areas where study is necessary are discussed, particularly with regard to economics, education, and tech-

nical areas, in which further knowledge is necessary.

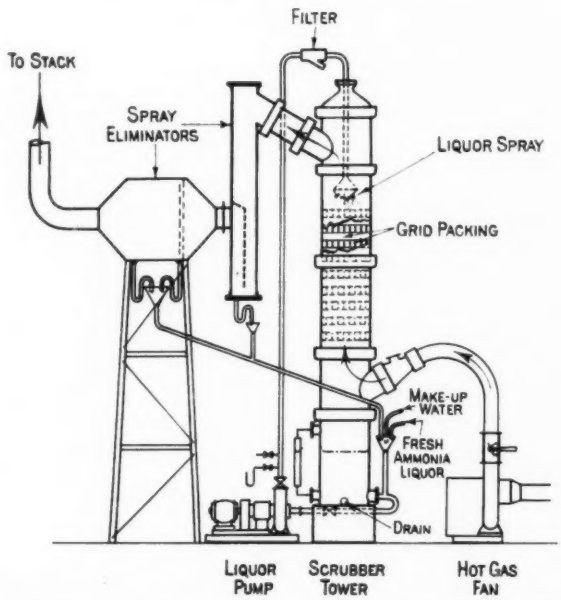
A typical example of how a development program has been approached is cited.

The Ammonia Process for the Removal of Sulphur Dioxide From Flue Gas, by H. E. Newall, Department of Scientific and Industrial Research, London, England. 1955 ASME International Air Pollution Congress paper No. **55—APC-3** (multilithographed; available to Jan. 1, 1956).

THE paper contains an account of experimental work in the laboratory, and with a small pilot plant on the Fulham-Simon-Carves Ammonia Process for the removal of oxides of sulphur from flue gas, and the recovery of the sulphur in the form of ammonium sulphate and sulphur.

The pilot plant scrubbed 25,000 cu ft of flue gas per hr with a concentrated solution containing ammonium sulphate, sulphite, bisulphite, and thiosulphate. Efficiencies of removal of oxides of sulphur of about 80 per cent were obtained.

In conjunction with the pilot-plant work, determinations were made of the partial pressures of sulphur dioxide and ammonia in equilibrium with solutions containing ammonium sulphite, bisulphite, sulphate, and thiosulphate, and with the scrubber liquors. The concentrations of sulphur dioxide and ammonia in the washed gas, when operating with various depths of grid packing in the scrubber, were correlated with the concentrations in equilibrium with the scrubber liquors. Two-stage scrubbing also was carried out using a concentrated solution of ammonium salts in stage one and a dilute solution of ammonium salts in the second stage. Efficiencies of removal of oxides of sulphur of 95 per cent with little loss of ammonia in the washed gas were achieved.



Pilot plant for the treatment of 25,000 cu ft of flue gas per hr

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Air-Pollution Control—Administrative Needs and Patterns, by A. C. Stern, Mem. ASME, U. S. Department of Health, Education, and Welfare, Public Health Service, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. 1955 ASME International Air Pollution Congress paper No. **55—APC-15** (multilithographed; available to Jan. 1, 1956).

LARGE areas in the United States are without effective governmental regulation of air pollution, according to this paper.

It is estimated that air pollution is recognized as a problem in close to 10,000 United States communities.

This estimate is based on a detailed survey made recently in New York State, showing that about 252 urban and 203 rural and suburban communities had air-pollution problems.

No local air-pollution or smoke-control ordinances exist in about 55 per cent of the New York State urban communities nor in about 3 per cent of the state's rural communities.

Only eight of the estimated 455 New York State communities with air-pollution programs have full-time personnel to cope with the problem.

Yet one half of the urban communities and one third of the rural communities would like to have their air-pollution problems effectively corrected.

In the long run it is poor public policy for federal agencies to give direct assistance and guidance to local communities that have no personnel adequately trained to administer an air-pollution-program, the paper states. The best vehicles through which to solve the air-pollution problem are county-wide or multicounty regional administrative units, similar to the one set up in the San Francisco Bay area.

In some cases it may be necessary to set up interstate agencies, such as have successfully solved interstate problems of water supply, water pollution, bridge, and port construction.

Unsolved Meteorological Problems in Air-Pollution Control, by E. W. Hewson, University of Michigan, Ann Arbor, Mich. 1955 ASME International Air Pollution Congress paper No. **55—APC-9** (multilithographed; available to Jan. 1, 1956).

THE paper first indicates the meteorological phases of the air-pollution problem in their broad outlines. Outstanding problems in single-source pollution are described and assessed and methods of attack proposed. Multiple-source pollution is similarly discussed and evaluated. Serious pollution problems presented by aeroallergens are outlined and the contribution of meteorology to their solution is suggested.

The paper concludes with a brief discussion of the long-term behavior of gases and fine particulates in the atmosphere.

Gaps in Our Knowledge of Air Pollution: Associated Health Implications, by E. A. Watkinson, Department of National Health and Welfare, Ottawa, Can. 1955 ASME International Air Pollution Congress paper No. **55—APC-17** (multilithographed; available to Jan. 1, 1956).

IT IS suggested that a distinction should be made between such well-known air-pollution incidents as the Meuse Valley, Donora, Poza Rica, and London. Instead of considering these occurrences as examples of a general type of situation which may arise, perhaps it would be sounder to recognize that the London episode of December, 1952, as contrasted with the others, represents a different type of pollution situation which may be termed "typically urban." In the author's opinion, the problem presented by

a number of major cities is this relatively featureless type of pollution.

While fairly well-defined damage to the human body can be associated with the acute effects following exposure to high concentrations of many toxicants, unfortunately this evidence is of little value in determining the results of long exposure. Possibly more definitive correlations might be obtained from properly designed surveys.

While investigations of the Windsor-Detroit type represent one approach to the solution of some of the problems in the field of air pollution, there are other methods which offer promise of providing basic data essential to an understanding of the field. Among the hypotheses which have been advanced to explain the unaccountably high irritant and toxic properties of urban smogs are those of synergism, adsorption, and solubility. These, however, require further investigation and particular attention should be paid to the design of the experiments.

Owing to the lack of basic experimental data, our knowledge of the health implications of these concepts is still beyond our reach at the present time and the final answer is dependent, in part, on work yet to be performed.

The Sarnia Survey: Action Without Compulsion, by B. C. Newbury, Ontario Research Foundation, Toronto, Can. 1955 ASME International Air Pollution Congress paper No. 54—APC-4 (multilithographed; available to Jan. 1, 1956).

VOLUNTARY co-operation between industry and a government industrial research bureau is considered the best method to tackle the problem of air pollution in the Sarnia area of Ontario Province, Can.

In the Sarnia area, six major industrial firms are contributing toward the cost of a survey and are actively helping one another to solve their pollution problems.

These companies co-operate with the Research Council of Ontario, which correlates government research in the province and which can give financial support to any approved research project that involves the co-operation of two or more companies.

Each company finances the tests carried out on its own site, while the cost of the Ontario Research Foundation's survey is divided half and half between the government of Ontario and the local industry.

The joint committee on air pollution in the Sarnia area makes no attempt at regulations. Its function is to discover the constituents and concentration of pollutants and to devise methods of suppression.

The paper discusses in detail the techniques and methods of the air-pollution survey in Sarnia and lists the following positive results:

A surge of public interest has followed the survey;

Other industries have asked to participate;

A constant flow of facts is being obtained from quantitive measurements;

Co-operation has been established with the city council;

Public relations have improved;

A spontaneous interchange of experience and data is being carried on between members of the pollution control; and

Studies of pollution problems, present and future, are being kept up in each plant.

A city should not have to legislate against air pollution and provide an enforcement agency as far as industry is concerned. Industry has the know-how, the manpower and the facilities to do the work far better itself; legislation should be reserved for use against the nonconformers only.

ASME Transactions for April, 1955

THE April, 1955, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following technical papers:

Visualization Studies of Secondary Flows With Applications to Turbomachines, by H. Z. Herzig and A. G. Hansen. (53—A-56)

The Use of Additives for the Prevention of Low-Temperature Corrosion in Oil-Fired Steam-Generating Units, by E. C. Huge and E. C. Piotter. (53—A-235)

Influence of Fine Particles on Corrosion of Economizer and Air-Preheater Surfaces by Flue Gases, by Peter Hodson. (53—A-232)

Applying Bearing Theory to the Analysis and Design of Pad-Type Bearings, by A. A. Raimondi and John Boyd. (53—A-84)

The Hydrodynamic Pocket Bearing, by D. F. Wilcock. (53—A-83)

The Influence of Surface Profile on the Load Capacity of Thrust Bearings With Centrally Pivoted Pads, by A. A. Raimondi and John Boyd. (53—A-166)

The Mechanics of the Simple Shearing Process During Orthogonal Machining, by B. W. Shaffer.

Turbine-Blade Vibration and Strength, by W. E. Trumpler, Jr., and H. M. Owens. (53—A-98)

Manpower and Other Factors Affecting Operating Costs in Steam Generating Stations, by V. F. Estcourt. (53—A-95)

The Economics of Large Reheat Turbine-Exhaust-End Size Selection, by D. W. R. Morgan, Jr., and S. D. Fulton. (53—A-93)

Economic Determination of Condenser and Turbine-Exhaust Sizes, by E. H. Miller and A. Sidun. (53—A-94)

Effect of Viscosity of Car-Journal Oils on Running Temperature and Other Characteristics of Journal-Bearing Performance, by W. M. Keller. (53—A-111)

Separation of Immiscible Liquids by Means of Porous Membranes, by G. V. Jordan, Jr. (53—A-221)

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Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Weather Aging of Plastics

Comment by L. Gilman[1]

THE Ordnance Corps recently completed a program involving the outdoor exposure of a large number of commercially available plastic materials. Among these materials were several wood-flour-filled phenolics and Lustron L2020, but no pigmented polystyrene material was included.

Exposures were conducted at four sites, three of which were comparable with the three sites employed in the Monsanto program[2] and the other of which was a subarctic site at Fort Churchill in Manitoba, Canada. Exposures of 1, 3, 7, 12, 18, 24, 30, and 36 months were conducted. Our data included tensile and elongation results and the electrical dissipation factor, but no other properties corresponding to those determined in the Monsanto program.

Results of Ordnance Corps Tests

With respect to the three properties in the Monsanto program as well as in the Ordnance Corps program, agreement was extremely close, despite differences in exposure methods and in exposure sites. However the Monsanto impact data on Lustron L2020 show essentially no change over four full years, whereas "work to produce failure," computed in the Ordnance Corps program as the area under the stress-strain curve obtained during tensile testing, dropped by over 90 per cent within one year. Both of these measurements are considered to reflect the toughness of the material, but work to produce failure seems, in this case, to have indicated more realistically the actual effect upon the material, as evinced by the great decreases in other properties.

Although it is true that wood-flour-filled phenolics exposed by the Ordnance Corps did not degrade too seriously at the tropic, desert, or temperate sites, the effect of subarctic exposure was by far the most severe. Some specimens had become too brittle to test by the end of $2\frac{1}{2}$ to 3 years. Since no exposure site of this type was used in the Monsanto program, it would be dangerous to rely upon the data for outdoor uses in cold climates. This surprising fact serves to point up sharply the need for a true cross section of climatological extremes in any outdoor-exposure program designed for obtaining reliable engineering data.

Summarizing, the investigation appears to have been an effective one.

In many ways the Monsanto data and the Ordnance Corps data corroborate each other.

Comment by R. R. Winans[3]

In general the authors' results follow closely those of the writer, which have been reported by ASTM. However, a few items might be clarified somewhat.

It is indicated in the paper that dimensional stability studies were made and this was done by measuring "the change of a length measured before exposure." For the phenolic material the specimen used was a $5 \times \frac{1}{2} \times \frac{1}{2}$-in. bar; however, in the case of the styrene materials a 4-in-diam $\times \frac{1}{2}$-in. disk was employed. The reason for using different specimen types is not obvious. It is further noted that the results of these studies are not presented in the paper. They should be of interest.

In the discussion of the effects of weather aging on heat distortion of the styrene materials, increased heat distortion is attributed to annealing of specimens as a result of the sun's radiation. It may be noted that the effects of exposure on heat distortion are not extensive but, if there is an increase in heat-distortion point, it is difficult to conceive that this is due to annealing. Annealing implies relief of stresses which should soften the material and, if anything, lower the heat-distortion point. It is believed that, if a change did occur, it may have been attributable to monomer or low molecular-weight-fraction evaporation, as indicated in the discussion on erosion. In effect, this removed a plasticizing agent, thus increasing the heat-distortion point. This is borne out by the fact that stiffness of the clear material increased considerably as shown in Table 1 of the paper.

The plots of exposure time versus accumulated sun hours may be misleading. It was considered by us that the total ultraviolet radiation was a better measure of the deteriorating effects of sun.

Authors' Closure

Dr. Gilman's comment on the rapid and drastic lowering of the area under the stress-strain curve in tension is a good one and is substantiated by our data.

Referring to Mr. Winans' comments, the measurement of dimensional change was discontinued after one year. The test was discarded because of the inconsistency in the results due to sample preparation. We realize that dimensional change is of considerable significance. Subsequent programs have led to improved techniques which now define this behavior.

Unpublished data show that the annealing of injection-molded styrene test specimens increases the heat-distortion temperature. In fact, it has been shown throughout the plastics industry that the relief of the molding stresses improves the ability of injection-molded styrene to withstand elevated temperatures at a given load without distortion. In some cases the heat-distortion temperature has been known to increase as much as 10 deg C after annealing.

Since there are no data on stiffness as defined by the modulus of elasticity in Table 1 of the paper, we presume Mr. Winans is referring to the increase in brittleness of the clear styrene as shown by the decrease of the tensile elongation and flexural deflection. Brittleness and thermal behavior, i.e., heat distortion, are not necessarily related. The increase in brittleness of the clear material is felt to result primarily from the degrading effect of ultraviolet radiation.

The exposure locations were so far apart and the climates so different that sun hours were thought to be adequate to

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[1] Chief, Plastics Research Section, Picatinny Arsenal, Dover, N. J.

[2] "Weather Aging of Styrene and Phenolic Plastics," by J. R. Taylor and C. H. Adams, MECHANICAL ENGINEERING, vol. 76, October, 1954, pp. 803–807.

[3] Material Laboratory, New York Naval Shipyard, Brooklyn, N. Y.

represent the ultraviolet radiation. For more precise work, a weather station, including a recording pyroheliometer, should be located on the exposure site.

J. R. Taylor[4] and C. H. Adams.[5]

Hydroelectric-Plant Turbine Design

Comment by R. A. Sutherland[6]

THE author[7] has performed a service in pointing out features which can be simplified with the object of reducing the cost per kilowatthour of energy produced by a plant. The simplification of the turbine would have an appreciable effect only in the case of small relatively low-head plants in which the equipment costs may be a relatively large proportion of the total installed cost per kilowatt. It is the writer's recollection that with plants of the order of 50,000–100,000 kw capacity, the total equipment cost is roughly one third of the cost including civil-engineering features, and in such cases economies in the prime movers would have little effect. In small low-head plants, however, the equipment might account readily for two thirds or more of the total cost, and simplification of the prime movers is more desirable.

The author rightly stresses the importance of reducing labor costs, and the use of automatic greasing is an important means to this end. Several plants with which the writer is familiar have been completely equipped, during or after construction, with automatic greasing. The results were very satisfactory not only from the point of view of operating costs but also in reducing maintenance of gate-stem bearings to a very marked extent. The writer would caution against an excessive use of "gadgets" aimed at reducing labor by substituting remote control. It has happened in some such cases that the relatively unskilled labor saved has, in effect, been replaced by the more skilled labor of a technician required to service the gadgets. In this phase, moderation should be the watchword.

The writer would favor the use of self-lubricated guide bearings wherever possible, but manufacturers seem to be averse to providing such bearings in the larger sizes. Simplification of the governor to a mere gate-closing or opening mechanism is also desirable in some cases, but the writer has found by inquiring that such simplification would result in little or no saving in cost.

Comment by J. Fisch[8]

The author calls attention to an increasingly important subject in connection with hydrogeneration and has suggested logical and interesting methods for reducing costs of turbines for marginal plants.

Referring to the section, Turbines Without Wicket Gates, of the paper, the writer's company had occasion to design, for one of its foreign associates, a gateless adjustable-blade turbine that has recently been placed in operation. The performance curve more nearly approaches curve C in the author's Fig. 4; i.e., a small amount in maximum efficiency is sacrified to maintain good efficiency to the right of the maximum efficiency point. This curve gives decidedly better water economy over a wide range of flow than can be obtained at the same specific speed with gateless fixed-blade turbines.

An unusual feature in the design of this turbine was the capacity of the blade servomotor which had to be greater than usual to overcome the increased tendency for the blades to open at overspeed. Also, the angular motion of the blade was designed to provide negative blade angle in the closed position to permit quick shutdown. Closure of the head gates is necessary to shut off the flow.

The over-all problem of how best to develop extremely low-head sites deserves wide study and research.

This involves consideration of the following:

1 Development of higher specific-speed runners than are now available, of fixed and adjustable-blade types.

2 More extensive use of vacuum-type settings, with fixed gates, fixed blades, and without head gates.

3 In line with comparatively recent wide use of submerged motors for pump drives, gateless turbines with submerged generators may be developed. During high flow conditions, some form of tail-water suppressor utilizing the waste flow over the spillway may be used to increase the power output.

Comment by J. S. Wells[9]

In recent years, automatic and remote supervisory control have resulted in unattended hydroelectric-plant operation with an appreciable decrease in plant operating costs. Fixed costs in plant investment now make up by far the greater portion of total hydroelectric power costs, and these can be reduced only by reduction in construction and equipment expenses. The experience of Wisconsin Michigan Power Company has shown that simplification of plant design and equipment can be a major item in the reduction of fixed costs.

The author's theme in several instances is supported by experience with the plants of the writer's company. The statement is noted that tightly closing and sealing wicket gates, in some cases, can eliminate the need for expensive butterfly valves in the penstock, and reference is made to the company's Peavy Falls plant. This plant has two 10,700-hp turbines operating at 92-ft head which employ rubber seals at the contact line between gates and at the clearance above and below the gates. The units have been in operation 11 years and annual inspection has shown the gate seals to be in good condition with no repairs needed to date. There is no evidence of excessive leakage although no such measurements have been made. Leakage is an important item at this plant since it is designed and operated for peaking purposes and at least one unit is shut down much of the time.

Features of Company Plants

The Way Dam plant on the Michigamme reservoir has several simplifying features incorporated into its construction. These include the use of simple relay and water-wheel controls, self-lubricating bearings, a semioutdoor plant design, and an induction generator. This plant was designed to utilize the potential energy available in the water discharged from the adjacent Michigamme reservoir at heads varying between 38 and 10 ft. It has been in operation at an average output of 1200 kw since 1949, and its performance has been very satisfactory. Operating and maintenance expenses for the plant have been low and compare favorably with the most economical plants on the system.

As the author has inferred, the Lower Paint Dam plant was tailored to utilize the energy available in the 85 cfs of water which is continuously discharged through the dam for maintenance of scenic beauty and fish life below. The

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[4] Physicist, Research Department, Plastics Division, Monsanto Chemical Company, Springfield, Mass.

[5] Group Leader, Research Department, Plastics Division, Monsanto Chemical Company.

[6] Hydraulic Engineer, Ebasco Services, Inc., New York, N. Y. Mem. ASME.

[7] "Economical Turbine Design for Marginal Hydroelectric Plants," by A. R. Klann, MECHANICAL ENGINEERING, vol. 76, November, 1954, pp. 905–908.

[8] Chief Engineer, S. Morgan Smith Company, York, Pa. Mem. ASME.

[9] Chief Engineer, Wisconsin Michigan Power Company, Appleton, Wis.

horizontal, fixed-propeller turbine operates at a 20-ft net head and is coupled to a 100-kw induction generator. The unit has no wicket gates and discharge is controlled by a manually operated type head gate. The plant is unattended and during periods of loss of load the unit operates at 900 rpm runaway speed until the line is energized or the head gate is closed. It has operated at runaway speed for a period of six hr with no apparent detrimental effects.

The Lower Paint dam plant was placed in service during July, 1952, and has operated almost continuously since that time. The propeller blades were welded to the hub in the field after final and proper setting had been determined. A chattering type of noise in the turbine casing prevailed until the addition of a $^3/_4$-in. vent line upstream from the blades which has reduced it about 60 per cent. This noise seemed to be coincident with a certain amount of vibration stemming from the same source. The thrust bearing, which was specifically designed for the unit, has given good service despite the pounding it has taken from the chattering effect described. The simplified controls for the unit also have given good results.

Redevelopment of Plants

It should be pointed out that redevelopment of existing plants may sometimes call for an entirely different type of installation than the original one. For example, a plant which was originally developed for river-run operation may now be more economically redeveloped as a peaking plant. Operating conditions which prohibited peaking operation in the original installation may have changed so that it may now be possible. The reverse also may be true.

In like manner, changed conditions may permit the redevelopment of an existing plant to utilize the economies available in remote supervisory control, automatic operation, or the various turbine simplifications described in the paper.

It is the belief of the writer that the development of simplified design and control of hydroelectric plants is a valuable step in the field of hydroelectric power generation.

Simplified Drafting

To the Editor:

Throughout industry there is much interest in a relatively new concept of engineering drawing known as "simplified drafting."[10] The McCormick Works, Advanced Engineering Department of International Harvester Company, is experimenting with a simplified-drafting method in an effort to reduce the amount of time spent in preparing detail drawings.

A tentative method has been developed and several studies have been made. A savings of 25 to 40 per cent in drafting time has been realized. In many cases the simplified drafting method allowed a 25 per cent reduction in paper and blueprinting costs.

To promote the use of simplified drafting most effectively within the department a committee was organized for the purpose of studying and reviewing the various methods of simplification applicable to our type of work. As a result we were able to compile a series of data sheets which standardized our simplification techniques. The data sheets which were circulated in booklet form to all members of the Engineering Department stimulated the consistent use of the simplified drafting methods.

Since we are pioneering this idea within International Harvester and have successfully used it within our department, we are quite interested in the efforts of other people. We would welcome the opportunity to exchange ideas and information and supply copies of our "Simplified Drafting" data sheets to anyone interested.

A. G. Barows.[11]

[10] "Simplified Drafting," by A. H. Rau, MECHANICAL ENGINEERING, vol. 76, June, 1954, pp. 491–496.

[11] Advanced Designer, Simplified Drafting Committee, International Harvester Company Chicago, Ill.

Reviews of Books

And Notes on Books Received in Engineering Societies Library

Engineer in Government

THE LIFE AND TIMES OF A HAPPY LIBERAL: A biography of Morris Llewellyn Cooke. By Kenneth E. Trombley. Harper and Brothers, New York, N. Y., 1954. Cloth, $5^1/_4 \times 8$ in., index, xvii and 270 pp., $4.

Reviewed by Gilbert E. Doan[1]

Most engineers work for corporations and measure their success by advancement within such organizations. This book is the story of a brilliant engineer who didn't need to work for a living through much of his life, but whose deep concern for the welfare of human beings has kept him working hard and effectively for more than 60 years. Although he is now 82 years of age, Morris Llewellyn Cooke is as active as ever.

Chairman of the Rural Electrification Administration under Roosevelt, arbitrator of the Mexican Oil expropriation dispute, head of the delegation which during World War II went to Brazil and helped restore that country's economy, badly shaken by the dislocations of the conflict, these are only samples of the contributions of a distinguished engineer to his country and his fellow men.

Of Quaker stock and of deep convictions, Mr. Cooke never believed that all desirable progress could be achieved within the rigid framework of the momentary economic, social, and political dogmas. His keen insight and crusading spirit make him impatient with such man-made restrictions. Thus he is a true liberal and visionary, subject only to the laws of God and man. This is Americanism at its best. When he found the private power companies exploiting the public early in the cen-

[1] Consultant, Pittsburgh, Pa.

tury, he exposed them mercilessly and got the rates reduced, as the book reveals. When he found labor misunderstood and snubbed, he wrote a book on labor and production with Philip Murray, promoting a better understanding between management and labor, without whitewashing labor. When the Mississippi valley was plagued with erosion, floods, and dust storms, F. D. Roosevelt called him in and without looking up from his work, said: "Morris, write a report on the Mississippi Valley." It was done and it was a brilliant piece of work.

A former First Assistant Secretary of the Interior, Michael W. Straus, writing in the *Washington Post* of October 24, 1954, says this engineer "did far more than most of his colleagues to jar the profession, its hierarchy and its societies into a comprehension that it was constitutional for engineers to have social objectives."

In both wars he was drafted to organize scientific management and co-operative labor relations for the Government, having been a close collaborator of Frederick W. Taylor and president of the American Society for Advancement of Management. He was a member of the Power Authority of the State of New York, which drew up the first drafts for the development of the St. Lawrence projects.

Moreover, Mr. Cooke has enjoyed his life thoroughly. Irresistible charm, a light touch, and a keen sense of fun have endeared him to his friends and dumfounded his enemies. Future engineers will look back on Morris Llewellyn Cooke as a trail blazer for their profession. Furthermore, the book is a stirring adventure story. David E. Lilienthal calls it "the story of a fabulous man—as inspiring as it is lively."

Books Received in Library...

ADHESION AND ADHESIVES. Fundamentals and Practice. Papers read at a Symposium held at Case Institute of Technology and a conference in London. John Wiley & Sons, Inc., New York, N. Y., 1954. 229 p., 11¼ × 8½ in., bound. $9.75. About a third of the papers presented relate to fundamentals—theory of adhesion, surface forces of solids, intermolecular forces, the relation between friction and adhesion, etc. The remaining papers cover a wide range of applications and materials, including adhesives for glass, wood, paper, metals, and textiles. Such subjects as aircraft structural adhesives, adhesion in road construction and maintenance, and joining aluminum are also covered, and there are several papers on test methods, including one on ultrasonic testing.

AGRICULTURAL PROCESS ENGINEERING. By S. M. Henderson and R. L. Perry. John Wiley & Sons, Inc., New York, N. Y., 1955. 402 p., 8⅝ × 5½ in., bound. $8.50. Engineering elements of the following unit operations, processes, devices, and procedures are treated: size reduction; cleaning and sorting; drying and dehydration; concentration by evaporation; refrigeration; mixing; materials handling; air conditioning; steam generation and use; heat transfer; pumps and fans; plant layout; work simplification; and instrumentation.

AIR AND OIL CYLINDERS IN INDUSTRIAL APPLICATIONS. By Elmer F. Heiser. Industrial Publishing Company, Cleveland, Ohio, 1954. 122 p., 10¾ × 8 in., bound. $5. A description in nontechnical language of practical procedures for the construction, selection, operation, application, and maintenance of fluid-power cylinders. In twenty-one chapters the author discusses such problems as cushion limitations and variations, operating speed, shock, air power-oil control, etc. Informal sketches illustrate the text.

AMERICAN MEN OF SCIENCE. Volume 1: Physical Sciences. Edited by Jaques Cattell. R. R. Bowker Company, New York, N. Y., 1955. 2180 p., 11¼ × 7¾ in., bound. $20. When complete in three volumes, the new edition of this standard biographical directory will contain almost double the number of names in the previous 1949, one-volume edition. The present volume includes over 43,000 biographies of living Americans and Canadians who have contributed to the advancement of physics, mathematics, chemistry, biological chemistry, meteorology, oceanography, acoustics, and research engineering. Authoritative information is given on date of birth, marital status, number of children, position, education, professional background, special fields of research, and society membership. Volumes 2 and 3, to be published, will cover the biological and social sciences.

AUTOMATIC CONTROL BIBLIOGRAPHY. By Warren F. Wade and Emory N. Kemler. Summary Reports. P.O. Box 176, Spring Park, Minn., 1955. 331 p., 9 × 7 in., bound. $15. This bibliography lists alphabetically by authors 1600 British and American periodical references, 1900–1954, most of them briefly annotated. In a partial attempt to classify the articles, lists by applications and areas of interest (e.g., automation, control panels, paper industry), are given following the alphabetical section. A bibliography of 120 books, of which a few are in French and a few in German, and a list of periodicals in the field are also included.

DESIGN OF MACHINE ELEMENTS. By Virgil Moring Faires. The Macmillan Company, New York, N. Y., third edition, 1955. 550 p., 9¼ × 6⅛ in., bound. $10. Basic theories of strength of materials and other pertinent theories are applied in this book to the actual design of the most common machine elements: links, gears, shafts, springs, bearings, belts, etc. The new edition is featured by expanded treatment of variable stresses and fatigue, more detailed coverage of mechanical properties of materials, and new design information for most of the elements. Originally written as a textbook, an effort has been made to make this edition useful also to practicing engineers.

ENGINEERING DYNAMICS. Volume 1: Theory of Elasticity: Analytical and Experimental Methods. By C. B. Biezeno and R. Grammel. Translated from the German by M. L. Meyer. Blackie & Son, Ltd., Glasgow, Scotland, 1955. 307 p., 10½ × 7¼ in., bound. 50s. Part of a four-volume translation of the author's "Technische Dynamik," second German edition, 1953, an advanced text for designers and research engineers. Roughly half of this first volume is a summary of fundamental laws and development of general theorems which are applied throughout the four volumes to a wide range of practical problems. The second half of the volume deals with analytical and experimental methods: Numerical solution of boundary value and eigenvalue problems, discontinuous methods of calculation, and various methods of experimental stress analysis.

ENGINEERING UNITS AND THE STROUD CONVENTION. By F. W. Thorne and A. C. Walshaw. Blackie and Son, Ltd., Glasgow, Scotland, 1954. 99 p., 8½ × 5½ in., paper. 3s,6d. The Stroud convention is a method of simple analysis which utilizes standard symbols representing physical quantities to form physical formulas or equations; then by replacing each symbol by a number multiplied by a proper unit in dealing with the arithmetical stage a numerical solution is obtainable. The further use of "unity brackets" (simple conversion forms) allows mixtures of units to be reduced to a consistent system.

ERFAHRUNGEN MIT SCHIFFSDIESELMOTOREN. By Hans Krug. 1954, Springer-Verlag, Berlin, Germany. 184 p., 10 × 6¾ in., bound. 30 DM. Practical engineering experiences in the operation of some sixteen large marine-diesel engines, mostly on oil tankers. The 39 chapters cover practically all parts of a large diesel, and represent the results of firsthand experience over a considerable period between the two world wars.

FALK'S GRAPHICAL SOLUTIONS TO 100,000 PRACTICAL PROBLEMS. Prepared and edited by Karl H. Falk. Columbia Graphs, Columbia, Conn., fourth edition, 1954. 419 p., 8¾ × 5½ in. bound. $6. A compilation of 400 worked-out graphs covering standard calculations for a wide range of practical problems in mechanics, hydraulics, physics, chemistry, shopwork, construction, electricity, weights and measures, and other fields. In this edition, workable formulas accompany many of the graphs, which are of the simple type giving the solution at the intersection of two lines traced from the known quantities.

HUMAN LIMBS AND THEIR SUBSTITUTES. Edited by Paul E. Klopsteg and Philip D. Wilson and others. Sponsored by Advisory Committee on Artificial Limbs, National Research Council. McGraw-Hill Book Company, Inc., New York, N. Y., 1954. 844 p., 9¼ × 6¼ in., bound. $12. Twenty-

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

five medical and engineering studies in the field of modern prosthetics are published in this volume under four broad groupings: Medical problems of the amputee, the upper limb and its substitutes, the lower limb and its substitutes, and adjustment of the limb to the amputee. Of particular interest to engineers are studies dealing with biomechanics of limbs, design of hands and hooks, materials for artificial limbs, controls and power sources for the electric arm, and others. References are listed after each chapter.

INDUSTRIAL DETERGENCY. Edited by Wm. W. Niven, Jr. Reinhold Publishing Corporation, New York, N. Y., 1955. 340 p., $9^1/_4$ × 6 in., bound. $8.75. This book is concerned with cleaning systems for solid objects, which involve the use of a liquid, a detergency-enhancing material, and a mechanical device, and with those systems which use a solvent liquid and mechanical device only. The approach is industry by industry, with separate chapters covering methods, materials, and equipment used in laundering, dry cleaning, textile processing, foods and beverages, the dairy industry, dishwashing, and the metals industries. Introductory chapters summarize fundamentals—detergency and detergent materials, and the last chapter considers the general industrial cleaning which is a part of maintenance, safety, and sanitation.

LA MACHINE-OUTIL. Edited by A. R. Métral. 1954, Dunod, Paris. Volume 2, 372 p., volume 3, 432 p., volume 6, 168 p., 11 × $7^1/_2$ in., bound. 5300, 5900, and 2500 Ffr. Part of an eight-volume set on machine tools, these three volumes deal respectively with the following topics: Volume 2. Design and operation of lathes and lathe tools, including semiautomatic and automatic operation, multiple-spindle machines, and many special types. Volume 3. Design and operation of drilling, boring, and milling tools, with discussion of special characteristics and uses, and descriptions of a circle range of machines currently in use. Volume 6. A detailed treatment of grinding wheels, dressing and truing methods, fine grinding and polishing equipment, with a special section on the sharpening of various types of metal-cutting tools. All volumes are extensively illustrated by photographs and detailed drawings.

MESSUNGEN AN ÖLFLAMMEN. (Mitteilungen aus dem Institut für Thermodynamik und Verbrennungsmotorenbau an der E.T.H., No. 13.) By Hanns H. Ott. Verlag Leemann, Zürich, Switzerland, 1954. 106 p., $9^1/_2 \times 6^5/_8$ in., paper. 15.60 Sw. frs. Results and analyses are presented of two laboratory investigations on oil flames: Measurements of flame shape, temperature, velocity, and radiation of an open flame; measurements of temperatures, velocities, etc., in a combustion chamber. The investigations were undertaken to provide information pertinent to the development of gas turbines and jet-power plants.

METALLBEARBEITUNG MIT NEGATIVEM SPANWINKEL. By Wackch Iwascheff. Verlag G. W. Den Boer, 1953, Middelburg, Holland. 140 p., 8 × $5^3/_4$ in., bound. 17.00 DM (Text in German). This small volume treats in detail the cutting of metals with tools having negative rake. It constitutes a summary of the published English, American, and German information on the subject supplemented by the author's own research.

METHODS OF MATHEMATICAL PHYSICS. Vol. 1. By R. Courant and D. Hilbert. Interscience Publishers, Inc., New York, N. Y., first English edition, 1953. 561 p., $9^1/_4 \times 6^1/_4$ in., bound. $9.50. A classic treatment of an important group of mathematical methods which is designed to unify the theory and tie it in with the physical problems to which it applies. A translation from the original German, this first of a two-volume set covers linear transformations, series expansions, the calculus of variations, vibration and eigenvalue problems, and other specialized aspects of eigenvalue problems.

OPERATIONS RESEARCH FOR MANAGEMENT. Edited by Joseph F. McCloskey and Florence N. Trefethen. Johns Hopkins Press, Homewood, Baltimore, Md., 1954. 409 p., $9^1/_4 \times 6$ in., bound. $7.50. A three-part study based largely on lectures delivered by industrialists, engineers, and others in a seminar at The Johns Hopkins University in 1952. Part one covers the scope and history of the field, and the relations between management and the operations analyst. The second part deals with methodology and the use of information theory, computing machinery, linear programming, game theory, and other techniques. Part three is made up of case histories drawn from the printing industry, the reliability of air-borne radar, sales promotion, etc. The selected bibliography includes references through September, 1954.

RICCI CALCULUS. An Introduction to Tensor Analysis and Its Geometrical Applications. By J. A. Schouten. Springer-Verlag, Berlin, Germany, second edition, 1954. 516 p., $9^1/_4 \times 6^1/_2$ in., bound. 58.60 DM. A comprehensive survey of the Ricci calculus in its modern form. Taken up in order are algebraic preliminaries, including a section on hybrid quantities; important analytical notions; linear connections, curvature, and normal coordinates; the theory of the Lie groups; and imbedding and the theory of higher curvature. The remainder of book deals with projective and conformal transformations of connections; the theory of variations, deformations, and movements; and miscellaneous examples from recent literature, including Kron's applications of tensor analysis to electric circuits. A bibliography of some 1400 references is given.

ROHRHYDRAULIK. Ein Handbuch zur praktischen Strömungsberechnung. By H. Richter. Second edition, 1954, Springer-Verlag, Berlin, Germany. 328 p., $9^1/_2 \times 6^1/_2$ in., bound. 34.50 DM. This practical monograph on the flow of fluids in pipes presents the underlying mechanical and thermal principles, analyzes research data, and provides detailed treatments of the design and construction of pipe lines for liquids and gases.

SYMPOSIUM ON EFFECT OF TEMPERATURE ON THE BRITTLE BEHAVIOR OF METALS WITH PARTICULAR REFERENCE TO LOW TEMPERATURES. (Special Publication No. 158.) American Society for Testing Materials, Philadelphia, Pa., 1954. 474 p., $9^1/_4 \times 6^1/_4$ in., bound. $7.50. The twenty-seven papers included cover the following broad fields: Brittle failures in ships and engineering structures; criteria of metal behavior for design engineers; metallurgical and mechanical factors; and significance and reliability of notch-toughness tests. Certain aspects of recent research on quenched and tempered steels at high strength levels, several types of cast iron, and titanium are dealt with in several of the papers, which, together, provide a summary of present knowledge of the subject, useful to designers, metallurgists, and engineers.

TABLE OF SALVO KILL PROBABILITIES FOR SQUARE TARGETS. (Applied Mathematics Series, No. 44.) National Bureau of Standards. Available from Superintendent of Documents, G.P.O., Washington 25, D.C., 1954. 33 p., $10^1/_4 \times 7^3/_4$ in., paper. $0.30. Although the terminology and notations used are associated with missile development, these four-place tables are useful to engineers generally as they are applicable to problems of planning in which predicted performance of programs, integrated operations, and individual pieces of equipment play an important role.

TABLES OF FUNCTIONS AND OF ZEROS OF FUNCTIONS. (Applied Mathematics Series, No. 37.) National Bureau of Standards. Available from Superintendent of Documents, G.P.O., Washington 25, D.C., 1954. 210 p., $10^1/_2 \times 8$ in., bound. $2.25. Eighteen short tables, including hypergeometric functions, Struve functions, Fourier coefficients, etc., some reprinted from various sources, are brought together in this volume for convenience of use. A brief discussion of the scope, origin, and usefulness of the tables is given in the introduction.

TABLES OF THE ERROR FUNCTION AND ITS DERIVATIVES. (Applied Mathematics Series, No. 41.) National Bureau of Standards. Available from Superintendent of Documents, G.P.O., Washington 25, D.C., 1954. 302 p., $10^1/_2 \times 8$ in., bound. $3.25. Error functions are of fundamental importance in many fields of classical and modern physics. The present expanded table is to 15 decimal places at intervals of 0.0001 between 0 and 1 and at intervals of 0.001 in the range from 1 to 5.6. The introduction discusses interpolation and asymptotic expansion methods, and provides a brief bibliography.

TASCHENBUCH DER LÄNGENMESSTECHNIK. With the collaboration of G. Berndt and O. Kienzle, edited by Paul Leinweber. 1954, Springer-Verlag, Berlin, Göttingen, and Heidelberg, Germany, 806 p., 7 × $4^3/_4$ in., bound. 27.00 DM. A handbook on the techniques and tools for linear measurement as related to design, shopwork, inspection, and quality control. It covers all types of gages—mechanical, optical, electrical, and pneumatic—including their manipulation, maintenance, and inspection, and deals with a wide range of both simple and composite measurement problems.

THEORETICAL ELASTICITY. By A. E. Green and W. Zerna. Oxford University Press, New York, N. Y., 1954. 442 p., $9^1/_4 \times 6^1/_4$ in., bound. $8. Main topics considered are finite elastic deformations, complex variable methods for two-dimensional problems for both isotropic and aeolotropic bodies, and shell theory. Treatment of the latter topics is confined to classical infinitesimal elasticity. Some mention is made of three-dimensional problems for isotropic and hexagonally aeolotropic bodies. General tensor notations are used throughout, vector notations whenever appropriate.

VERBINDUNGSELEMENTE DER FEINWERKTECHNIK. (Konstruktionsbücher, No. 14.) By Hermann Pöschl. Springer-Verlag, Berlin, Germany, 1954. 108 p., 9 × 6 in., paper. 13.50 DM. A comprehensive survey of fastening devices and methods for assembling components in quantity production. The descriptive text covers screwed and riveted connections, welded and soldered joints, and a wide variety of fasteners and connectors for both fixed joints and demountable connections such as layonet joints, pin and slot connectors, etc. Detailed line drawings are provided throughout.

Interpretations

THE Boiler and Pressure Vessel Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N.Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting January 21, 1955, and approved by the Board on March 14, 1955.)

CASE No. 1174–2 (REOPENED)

(Special Ruling)

Delete allowable design stress values for temperatures of 350 and 400 F in the *Reply*.

Add the following Cautionary Note at the end of the *Reply:*

> Appendix NF suggests that, in certain instances, the user should consult with the material producer to assure himself that the material is satisfactory for the intended use. With this alloy, one such instance is the use of cold-worked material held for a long period at temperatures near 212 F.

CASE No. 1177–1 (REOPENED)

(Special Ruling)

Inquiry: Expansion joints are being used in pressure vessel installations. The Code makes no specific provisions for them. Under what conditions may an expansion joint be used as an integral part of a Code pressure vessel?

Reply: The Code does not contain rules for the design of expansion joints but such joints may be used under the conditions of Par. U-2(c) giving due consideration to Par. UG-22. When the expansion joint is manufactured by other than the vessel manufacturer, the manufacturer of the joint shall execute a partial data report as required by Par. UG-120(b), using Form U-2 as far as applicable, plus any necessary supporting data in order that the final inspector of the completed vessel may have the information necessary to satisfy himself that the expansion joint is adequate for the vessel in which it is to be used and that the materials and welding are in accordance with Code rules. The expansion joint shall not be stamped with the Code symbol but the partial data report and any necessary supporting data shall be the final inspector's authority to witness the application of the Code symbol to the completed vessel provided the vessel manufacturer also satisfies himself that the joint is adequate and properly installed for the intended service.

CASE No. 1198

(Interpretation of Par. UCS-66(d)(2))

Inquiry: Par. UCS-66(d) (2) of Section VIII of the Code exempts carbon and low-alloy steels from impact tests when the operating cycle is such that the pressure at −20 F is less than one fifth of the maximum allowable working pressure at 100 F. May this exemption be applied to vessels that operate at temperatures below −20 F and to vessels for which the pressure and temperature are not fixed by the saturation pressure-temperature relationship of the contained fluid?

Reply: It is the opinion of the Committee that the intent of Par. UCS-66(d) (2) will be met under the following conditions:

(1) No impact test is required for materials used in a vessel subjected in service to a pressure which is solely a function of the saturation pressure-temperature relationship, provided this relationship is such that the pressure at −20 F and below does not exceed one fifth of the maximum allowable working pressure, and provided the design pressure is not less than the pressure corresponding to 100 F at saturation.

(2) No impact test is required for material used in a vessel that is to operate at temperatures below −20 F provided the maximum design pressure of the vessel is determined on the basis of a reduced stress equal to 20 per cent of the allowable stress value prescribed for the materials by the rules of this Section.

(3) The vessel is equipped with a suitable relieving device set at a pressure not exceeding the maximum design pressure.

(4) The relieving device is adequately protected against freezing due to condensation of moisture in the surrounding atmosphere.

CASE No. 1199

(Special Ruling)

Inquiry: Under what conditions may non-metallic materials be used as pressure-resisting parts if these parts are enclosed within an assemblage of metallic parts which are bolted together in such a way as to enclose the non-metallic material except for possible narrow gaps between adjoining metallic parts?

Reply: It is the opinion of the Committee that non-metallic materials may be used as pressure-resisting parts of Code vessels under the conditions specified in the *Inquiry* provided the following requirements are met:

(1) The metallic parts of the construction shall meet all the requirements of Section VIII of the Code.

(2) The chemical composition and mechanical properties of the non-metallic materials shall be made available to the authorized inspector and shall be subject to his approval. The mechanical properties shall include tensile strength, compressive strength, shear strength, and elongation, and their change with time for temperatures up to a temperature not less than 100 F greater than the design temperature. The tests shall be made by independent competent testing laboratory.

(3) The enclosing metallic assemblage shall be so constructed as to produce compressive internal forces across any plane that may be assumed to be cut through the enclosed non-metallic material. The total value of these internal compressive forces across any plane shall be at least one and one-half times the total fluid pressure which acts across the plane.

(4) The average compressive stress in the non-metallic material across any plane due to pressure applied to it by the enclosing assembly shall not exceed one fifth of its compressive strength at the design temperature.

(5) When the parts of the enclosing metallic assembly are connected by bolting, the gaps between adjacent metallic parts shall not be wider than the thickness of non-metallic gaskets used in conventional bolted flange joints.

(6) This construction must not depend for its structural stability on the non-metallic parts.

CASE No. 1201

(Special Ruling)

Inquiry: Is it permissible in welded construction conforming to the requirements of Section VIII of the Code to use arc-welded steel pipe conforming to Grade B of ASTM Specification A 139-53?

Reply: It is the opinion of the Committee that arc-welded steel pipe that meets the requirements of ASTM Specification A 139-53, Grade B, may be used in the construction of unfired pressure vessels under the rules of Section VIII of the Code provided the following requirements are also met:

(1) All welds used in fabricating the pipe shall be two-pass single-welded butt joints with backing, made by the automatic submerged arc-welding process.

(2) The manufacture of the pipe shall meet the rules for fabrication in Pars. UW-26 to UW-38, inclusive, of Section VIII.

(3) The limiting requirements in Pars. UCS-6(b)(1) to UCS-6(b)(5) shall apply, except that the maximum wall thickness shall be $^1/_2$ in.

(4) The nominal inside pipe diameter shall not exceed 30 in.

(5) The maximum operating pressure shall be 250 psi.

(6) The maximum allowable *SE* value shall be 8100 psi. This is the net stress value after deducting for joint efficiency and for exemption from spot examination.

(7) The final inspector of a vessel in which pipe permitted by this Case is used may waive the partial data report required by Par. UG-120(b) for welding done in other shops, provided he assures himself by visual examination that the welds are free from cracks and other surface defects and that the requirements of Pars. UW-26 to UW-38, inclusive, have been met.

Case No. 1202

(*Special Ruling*)

Inquiry: Is it permissible to construct welded vessels for use in the range of —150 F to 650 F under the requirements of Section VIII of the Code using copper chromium nickel steel of the following chemical composition and physical properties?

CHEMICAL COMPOSITION, PER CENT

Carbon, max	0.12
Manganese*	0.55 to 1.00
Phosphorus, max	0.04
Sulfur, max	0.04
Chromium*	0.50 to 0.95
Nickel*	0.50 to 0.95
Copper	0.40 to 0.75
Silicon*	0.10 to 0.35
Aluminum	0.04 to 0.30

*AISI Standard Variations for Check Analysis shall apply.

TENSILE PROPERTIES

Tensile strength, psi	60,000 min
Yield point, psi	30,000 min
Elongation in 8 in., per cent	21 min[a]
Elongation in 2 in., per cent	24 min[b]

[a] For material under $^5/_{16}$ in. in thickness, a deduction from the percentage of elongation in 8 in. specified above of 1.25 per cent shall be made for each decrease of $^1/_{32}$ in. of the specified thickness below $^5/_{16}$ in.

For material over $^1/_4$ to $^3/_4$ in., inclusive, in thickness, if the percentage of elongation of an 8-in. gage length test specimen falls not more than 3 per cent below the amount prescribed above, the elongation shall be considered satisfactory provided the percentage of elongation in 2 in. across the break is not less than 25 per cent.

(Note: A characteristic of certain types of alloy steels is a local disproportionate increase in the degree of necking down or contraction of the specimens under tension test, resulting in a decrease in the percentage of elongation as the gage length is increased. The effect is not so pronounced in the thicker plates.)

For material over $^3/_4$ in. in thickness, a deduction from the percentage of elongation in 8 in. specified above of 0.5 per cent shall be made for each increase of $^1/_8$ in. of the specified thickness above $^3/_4$ in. This deduction shall not exceed 3 per cent.

[b] For material over $3^1/_2$ in. in thickness, a deduction from the percentage of elongation in 2 in. specified above of 0.5 per cent shall be made for each increase of $^1/_2$ in. of the specified thickness above $3^1/_2$ in. This deduction shall not exceed 3 per cent.

BENDING PROPERTIES

The bend test specimen shall withstand being bent cold (room temperature) through 180 deg without cracking on the outside of the bent portion to an inside diameter which shall have the relation to the thickness of the specimen prescribed below. When the test is made on a specimen reduced in thickness, the rolled surface shall be on the outer curve of the bend.

BEND DIAMETERS

Thickness of Material, In.	Ratio of Bend Diameter to Thickness of Specimen
1 and under	2
Over 1 to $1^1/_2$, incl	$2^1/_2$
Over $1^1/_2$ to 3, incl	3

All other requirements in accordance with Specification SA-212.

Reply: It is the opinion of the Committee that the material specified in this *Inquiry* may be used in the range of —150 F to 650 F under the requirements of Section VIII of the Code with the following additional provisions:

(1) The impact test requirements of Par. UG-84 shall be met.

(2) The material shall be normalized before welding.

(3) The maximum allowable stress value shall be 15,000 lb per sq in.

(4) The completed vessel shall be stress relieved.

(5) All welded butt joints shall be fully radiographed.

(6) The specification test bars shall be normalized and then stress relieved at 1100 to 1200 F prior to test.

(7) The qualification of the welding procedure and the welders shall conform to the requirements of Section IX. A separate welding procedure shall be made for this material.

Case No. 1203

(*Special Ruling*)

Inquiry: Is it permissible to use a roller-equipped jig designed for bottom-ejection of test specimen in lieu of the "Standard Test Jig" for making guided bend specimens, as required by Section IX of the ASME Code? The roller test jig shall conform to the following limitations:

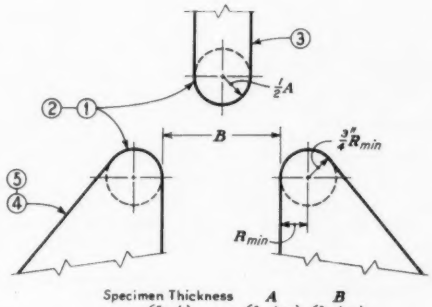
(1) The ram to be used with the roller jig shall be of identical dimension to the ram shown in Fig. Q-8 and QN-8, Section IX of the 1953 ASME Pressure Vessel Code.

(2) One roller may be made adjustable in the horizontal direction, so that the specimens of t thickness may be tested in the same jig.

(3) Rollers are to be hardened and free to rotate.

(4) The rollers shall be high enough above the bottom of the jig so that the specimens will clear the rollers when the ram is in the low position.

Reply: It is the opinion of the Committee that a roller-equipped jig designed for bottom-ejection of test specimens, as shown in the accompanying sketch, is



Specimen Thickness (Inch)	A (Inches)	B (Inches)
$\frac{3}{8}$	$1\frac{1}{2}$	$2\frac{3}{8}$
$\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{3}{8}$
t	$4t$	$6t+\frac{1}{8}$

satisfactory for use in lieu of the jig shown in Figs. Q-8 and QN-8, Section IX of the 1953 ASME Boiler and Pressure Vessel Code. Accordingly, the fundamental design features which are mandatory in the Guided-Bend Test Jig, Figs. Q-8 and QN-8, are established as follows:

(1) Either hardened and greased shoulders or hardened rollers free to rotate.

(2) The shoulders or rollers shall have a minimum bearing surface of 2 in. for placement of the specimen.

(3) The ram shall be fitted with an appropriate base and provision for attachment to the testing machine, and shall be designed to minimize deflection and misalignment.

(4) If desired either the rollers or the roller supports may be made adjustable in the horizontal direction so that specimens of t thickness may be tested in the same jig.

(5) The roller supports shall be fitted with an appropriate base designed to safeguard against deflection or misalignment and equipped with means for maintaining the rollers centered, mid-point and aligned with respect to the ram.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

As NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Comments should be addressed to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers, 1952

PREAMBLE Add the following paragraph:

A pressure vessel in which an organic fluid is vaporized by the application of heat resulting from the combustion of fuel (solid, liquid, or gaseous) shall be constructed under the provisions of Section I. Vessels in which vapor is generated incidental to the operation of a processing system, containing a number of pressure vessels such as used in chemical and petroleum manufacture, are not covered by the rules of Section I.

PAR. P-275 Add the following sentence to subparagraph (1):

(1) This method should not be used on a boiler with a superheater or reheater.

PAR. P-291 Delete the sentence at the end of the second paragraph reading:

The lowest permissible water level for the usual types of boilers is given in Par. A-21.

PAR. P-340 Add as a new paragraph:

P-340 The following special rules shall apply to vapor generators in which organic fluids are vaporized.

(a) The manufacturer shall be responsible for providing in the design the limited heat absorption rates, proper furnace proportions, etc., which will permit satisfactory and safe operation of the vaporizer under all conditions of operation.

(b) Safety valves shall be of a totally enclosed type so designed that vapors escaping beyond the valve seat shall not discharge into the atmosphere, except through an escape pipe that will carry such vapors to a safe point of discharge outside of the building. A suitable condenser that will condense all the vapor discharged from the safety valve may be used in lieu of piping the vapors to the atmosphere. The safety valve shall not have a lifting lever. The vaporizer shall be designed in accordance with the rules in this Code for a working pressure of at least 50 psi above the operating pressure at which it will be used.

Safety valves shall be disconnected from the vaporizer at least once yearly, when they shall be inspected, repaired if necessary, tested, and then replaced on the vaporizer.

(c) Gage glasses shall be of the flat glass type with forged steel frames. Gage cocks shall not be used.

(d) Suitable drain valves of the globe or angle type may be used in lieu of the blowoff valve required in Par. P-308.

PAR. A-21 Revise to read:

Fire-actuated fusible plugs, if used, shall be located at the lowest permissible water level as determined by the boiler manufacturer; steam-actuated plugs, if used, shall be so located that they will operate when the water level is at the point where a fire-actuated fusible plug would be located.

Delete (a) to (m) inclusive.

PAR. A-46 Add the following sentence to subparagraph (1):

This method should not be used on a boiler with a superheater or reheater.

Low-Pressure Heating Boilers, 1952

PAR. H-23 Revise to read:

The diameter of a screw stay shall be taken at the bottom of the thread, provided this is the least diameter. No screwed stay, or stay welded in by fusion process, shall have a cross-sectional area less than 0.44 sq in.

Unfired Pressure Vessels, 1952

PAR. UG-47(b) Add the following to the end of the subparagraph: . . . . . "except for welded construction covered by Par. UW-19."

PAR. UG-84 Delete the following from subparagraph (b) (3): "with diameters differing not more than 6 in."

FIG. UW-19.1 Revise as shown below.

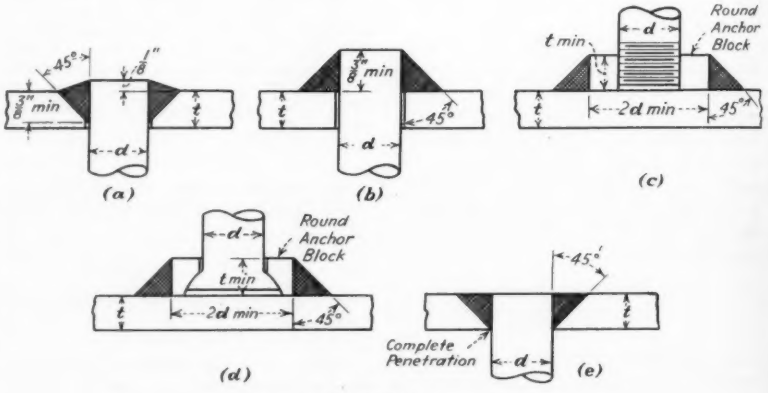


Fig. UW-19.1

PAR. UW-51 Add the following to the first sentence of subparagraph (e) (4): ". . . . . being radiographed, but for thin plates need not be less than 0.005 in."

PAR. UW-52 Add the following to subparagraph (a): ". . . . . and except for those vessels or parts of vessels designed for external pressure only."

TABLE UNF-23 Copper-Silicon A, C, D, SB-96 Plates & Sheet: Revise stress value under "250 F" from 10,000 to 11,700.

Under Charts for External Pressure add Fig. UNF-28.14 "Chart for Determining Shell Thickness of Cylindrical and Spherical Vessels under External Pressure." (NOTE: This figure is available from the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th St., New York 18, N. Y.)

With Notes on the Engineering Profession

The Engineer and the World of Science Keynotes ASME Diamond Jubilee Semi-Annual Meeting

- **Headquarters—Hotel Statler, Boston, Mass., June 19–23**
- **Technical Sessions, Inspection Trips, Business and Society-Policy Meetings, and Social Events are scheduled**

Tentative Program

MONDAY, JUNE 20

8:00 a.m.

Registration

9:30 a.m.

Applied Mechanics (I)

Shortcomings of Present Methods of Measuring and Simulating Vibration Environments, by *C. T. Morrow,* Hughes Aircraft Co., and *R. B. Muchmore,* Ramo-Wooldridge Corp. (Paper No. 55—SA-2)

Inertia Forces in Lubricating Films, by *R. S. Brand,* University of Connecticut (Paper No. 55—SA-1)

Nutation of a Free Gyro Subjected to an Impulse, by *B. T. Plymale* and *Robert Goodstein,* Boeing Airplane Co. (Paper No. 55—SA-3)

9:30 a.m.

Rubber and Plastics (I)—Wood Industries (I)

Symposium on Fundamentals of Adhesives

Some Fundamental Aspects of the Problem of Rubber-Metal Adhesion[1]

Stress Distributions and Design Data for Adhesive Lap Joints Between Circular Tubes[1]

Measurements of the Contribution of the Electrostatic Component to the Strength of an Adhesive Bond, and Its Use in Quality Control[1]

9:30 a.m.

Hydraulic (I)

Fluid Mechanics Meeting

[1] Preprints not available—see box on page 460.

Main bay of General Electric's Building 64, main assembly shop, at West Lynn, Mass., in which all heavy-machine work, assembling, and testing of turbines are done. This bay, to be inspected during ASME Diamond Jubilee Semi-Annual Meeting, is 1000 ft × 85 ft. It is served by 12 overhead traveling cranes.

Resistance Coefficients for Accelerated and Decelerated Flows Through Smooth Tubes and Orifices[1]

Development of Boundary Layers of Mixed Tangential and Axial Flows in an Annular Space of Revolution[1]

Streamlined Pitot Tube Bar for Measuring Water Flow in Large Pipes, by *F. Numachi, H. Murai, and S. Abe,* Institute of High Speed Mechanics, Tôhoku University, Sendai, Japan (to be presented by *G. F. Wislicenus,* Pennsylvania State University) (Paper No. 55—SA-25)

9:30 a.m.

Heat Transfer (I)—Metal Processing (I)

Thermal Properties of Titanium Alloys and Selected Tool Materials, by *E. G. Loewen,* Massachusetts Institute of Technology (Paper No. 55—SA-45)

Response of Temperature-Measuring Instruments to Thermal Transients, by *J. A. Clark,* Massachusetts Institute of Technology (Paper No. 55—SA-18)

9:30 a.m.

Materials Handling (I)—Railroad—Production Engineering (I)

Container Size and Pallet-Pattern-Selection Criteria for Use on 40-Inch × 48-Inch Pallets, by *C. J. Heinrich* and *J. P. Akrep,* Naval Supply Depot, Bayonne, N. J. (Paper No. 55—SA-8)

Unit Loads for Bulk Materials[1]

9:30 a.m.

Power (I)

Selective Silica Carry-Over in Steam, by *E. E. Coulter, E. A. Pirsh,* and *E. J. Wagner, Jr.,* The Babcock & Wilcox Co. (Paper No. 55—SA-19)

1200-Psi Installation at Millinocket Paper Mill[1]

A Comprehensive Training Program for Power-Plant Personnel, by *Harold Grasse,* Black & Veatch (Paper No. 55—SA-41)

12:15 p.m.

President's Luncheon

Toastmaster: *Lewis K. Sillcox,* Past-President and Hon. Mem. ASME

Speaker: *David W. R. Morgan,* President and Fellow ASME

Subject: **The Engineer's Role in the World of Science**

2:30 p.m.

Education—Junior (I)—Management (I)

Panel on The Increased Emphasis Upon Basic Sciences in Engineering Curricula

Harry K. Ihrig, Allis-Chalmers Manufacturing Co.
Clement J. Freund, University of Detroit
Kerr Atkinson, consulting engineer, Boston, Mass.
F. Everett Reed, Arthur D. Little, Inc.

2:30 p.m.

Rubber and Plastics (II)—Wood Industries (II)

Symposium on Applications of Adhesives

Heat-Cured Resin Adhesives[1]

Adhesives—A Third Dimension in Fastening and Joining[1]

Adhesive Bonding of Metals[1]

2:30 p.m.

Process Industries (I)

Part-Load Performance in Centrifugal Refrigeration[1]

Centrifugal-Refrigeration Industrial Applications, by *Elbridge Gammill,* Carrier Corp. (Paper No. 55—SA-9)

2:30 p.m.

Metals Engineering (I)—Production Engineering (IIA)—Metal Processing (II)

The Relation Between Grinding Conditions and Thermal Damage in the Workpiece[1]

Residual Stresses in Cold-Finished Steel Bars and Their Effect on Manufactured Parts, by *E. S. Nachtman,* LaSalle Steel Co. (Paper No. 55—SA-49)

[1] Preprints not available—see box on this page

Preprint Orders

ONLY preprints of *numbered* ASME papers will be available. Some of these papers may not be available in time to permit your receiving them in advance of the meeting. Your order will be mailed only when the complete order can be filled unless your request that all papers available ten days before the meeting be mailed at that time. Please order only by paper *number;* otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the meeting.

Preprints of ASME papers may be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents each to members; 50 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons, or coupons which may be purchased from the Society. The coupons, in lots of ten, are $2 for members; $4 for nonmembers.

Preprints of unnumbered papers listed by title only in the tentative program *are not available* because the review of these manuscripts had not been completed when the program went to press. The author's name and preprint number will appear with the paper title in the final program (final program available only at meeting) as well as the issue of MECHANICAL ENGINEERING containing an account of the meeting, if the paper is recommended for preprinting.

Measuring the Thermal Diffusivity of Metals at Elevated Temperatures, by *M. A. El-Hifni* and *B. T. Chao,* University of Illinois (Paper No. 55—SA-36)

2:30 p.m.

Hydraulic (II)
Turbomachinery

A Comparison of Regenerative-Pump Theories Supported by New Experimental Data, by *Yasutoshi Senoo,* Kyushu University, Fukuoka, Japan, presently Visiting Fellow, Massachusetts Institute of Technology (Paper No. 55—SA-44)

Analysis of Traction Pumps, by *F. S. Weinig,* General Electric Co., formerly Air Research & Development Command (Paper No. 55—SA-35)

2:30 p.m.

Heat Transfer (II)

Local and Average Coefficients of Heat Transfer for Horizontal Laminar Motion of Fluids in a Circular Tube, by *Charley Scott,* Mississippi State College, *G. E. Eggleston,* Douglas Aircraft Co., and *W. L. Sibbitt,* Purdue University (Paper No. 55—SA-17)

Laminar-Free Convection From a Vertical Plate With Uniform-Surface Heat Flux, by *E. M. Sparrow* and *J. L. Gregg,* NACA, Lewis Flight Propulsion Laboratory (Paper No. 55—SA-4)

Heat Transfer to Laminar Flow in a Round Tube or Flat Conduit—the Graetz Problem Extended[1]

2:30 p.m.

Materials Handling (II)—Production Engineering (IIB)

The Development of Automation in Metalworking[1]

Maintaining an Automated Plant, by *Norman Conrad,* Ford Motor Co. (Paper No. 55—SA-43)

Registration Schedule

Sunday, June 19, 12:00 noon to 8:00 p.m.
Monday, June 20, 8:00 a.m. to 5:00 p.m.
Tuesday, June 21, 8:00 a.m. to 5:00 p.m.
Wednesday, June 22, 8:00 a.m. to 8:00 p.m.
Thursday, June 23, 8:00 a.m. to 3:00 p.m.

2:30 p.m.

Power (II)—Fuels (I)

Design of Furnaces for Firing Combination Fuels[1]

Margins for Future Improvement of the Steam Cycle[1]

Horizontal Bolt and Flange Heating of Hp Turbine Cylinders of Both Single and Double-Shell Designs[1]

4:45 p.m.

Business Meeting

Presiding: *David W. R. Morgan,* President and Fellow ASME

Announcement of location of 1956 Semi-Annual Meeting
Election of Nominating Committee for 1956

8:00 p.m.

Boston "Pops" Concert

TUESDAY, JUNE 21

8:00 a.m.

Registration

9:00 a.m.

Inspection Trip

Quartermaster Research and Development Center

9:30 a.m.

Process Industries (II)

The Nonaqueous Process for Portland-Cement Manufacture, by *J. C. Witt,* consulting engineer, Chicago, Ill. (Paper No. 55—SA-26)

Process Design of Tubular Heaters, by *L. A. Mekler,* Petro-Chem Process Co. and Petro-Chem Development Co. (Paper No. 55—SA-27)

9:30 a.m.

Metals Engineering (II)—Applied Mechanics (II)

On the Relations Between Various Laboratory-Fracture Tests[1]

Avoidance of Fracture in Large-Machine Components[1]

Need for Information on the Fracture of Dual Materials[1]

9:30 a.m.

Management (II)

Elements of Job Environment Needing Minimum Standards of Control, by *I. Matelsky,* General Electric Co. (Paper No. 55—SA-33)

Engineering Control of Occupational Health Hazards[1]

Effects of Noise in the Job Environment[1]

9:30 a.m.

Heat Transfer (III)

Average and Local Heat Transfer for Crossflow Through a Tube Bank, by *R. A. DeBortoli, R. E. Grimble, and J. E. Zerbe,* Westinghouse Electric Corp. (Paper No. 55—SA-51)

Heat Transfer to Turbulent Boundary Layers With Variable Free-Stream Velocity[1]

9:30 a.m.

Metal Processing (III)

The Effects of High-Frequency Vibrations in Grinding, by *L. V. Colwell,* University of Michigan (Paper No. 55—SA-12)

The Role of Chip Thickness in Grinding, by *G. S. Reichenbach,* Massachusetts Institute of

Technology; *Serope Kalpakcioglu*, Galata Persembe Pazar, Istanbul, Turkey; *J. E. Mayer, Jr.*, Headquarters Research and Development Command; and *M. C. Shaw*, Massachusetts Institute of Technology (Paper No. 55—SA-37)

Inorganic Grinding Fluids for Titanium Alloys, by *M. C. Shaw*, Massachusetts Institute of Technology, and *C. T. Yang*, Ford Motor Co. (Paper No. 55—SA-39)

9:30 a.m.

Power (III)—Nuclear Engineering (I)

Boiling Reactors

Application of Boiling Reactors to the Generation of Electrical Energy[1]

A 180-MW (net) Boiling-Flashing Reactor Power Plant (tentative title)[1]

Power Removal From Boiling Nuclear Reactors[1]

9:30 a.m.

Instruments and Regulators

A New Method of Evaluating Dynamic Responses of Counterflow and Parallel-Flow Heat Exchangers, by *H. M. Paynter* and *Y. Takahashi*, Massachusetts Institute of Technology (Paper No. 55—SA-50)

Application of Some System-Engineering Principles to the Design of a Fuel-Supply System[1]

Analytical Methods of Determining the Dynamic Response of Industrial Thermometers, by *T. C. Linahan*, Minneapolis-Honeywell Regulator Co. (Paper No. 55—SA-52)

2:30 p.m.

75th Anniversary Panel (I)

The Engineer and the World of Science

Panel members to be announced

6:00 p.m.

Social Hour

7:00 p.m.

Banquet

Toastmaster: *F. S. Blackall, jr.*, past-president and Fellow ASME
Address: *Detlev W. Bronk*, president, National Academy of Sciences, Washington, D. C.

9:00 p.m.

Dance

WEDNESDAY, JUNE 22

8:00 a.m.

Registration

9:30 a.m.

75th Anniversary Panel (II)

The Engineer and the World of Science

Panel Members

Sir Vincent de Ferranti, chairman, World Power Conference (England)

Ernest F. Mercier, engineer (France)

Richard E. Hearts, president, Engineering Institute of Canada

Hilding V. Tornebohm, president, International Organization for Standardization (ISO)

12:15 p.m.

Machine Design Luncheon

Toastmaster: *John Haydock*, chairman, ASME Machine Design Division; editor, *Metal Working*, Sutton Publishing Co., White Plains, N. Y.

Speaker: *Richard Alt*, staff associate, Arthur D. Little, Inc., Cambridge, Mass.

Subject: **Research-Based Industry in New England**

2:30 p.m.

Machine Design (I)

Flow of a Compressible Fluid in a Thin Passage, by *S. K. Grinnell*, Massachusetts Institute of Technology (Paper No. 55—SA-13)

The Effect of Oil-Column Acoustic Resonance on Hydraulic-Valve "Squeal," by *F. W. Ainsworth*, Minneapolis-Honeywell Regulator Co. (Paper No. 55—SA-14)

2:30 p.m.

Heat Transfer (IV)

A New Electrical Analog Method for the Solution of Transient Heat-Conduction Problems, by *G. Liebmann*, Associated Electrical Industries, Ltd., Aldermaston, Berkshire, England (Paper No. 55—SA-15)

Matrix Analysis of Heat-Transfer Problems, by *L. A. Pipes*, University of California and U. S. Naval Ordnance Test Station (Paper No. 55—SA-34)

On a Generalized Procedure for the Calculation of Thermal-Radiation Transfer[1]

2:30 p.m.

Production Engineering (III)—Management (III)

Manufacturing Engineering—A Key to Increased Production and Lower Costs, by *J. A. Miller*, Westinghouse Electric Corp. (Paper No. 55—SA-5)

An Effective Cost-Reduction Program, by *L. J. Brozek, P. A. Noble*, and *M. B. Parmelee*, Westinghouse Electric Corp. (Paper No. 55—SA-6)

2:30 p.m.

Power (IV)—Nuclear Engineering (II)

Nuclear-Power Equipment

Central-Station Reactors[1]

Fast Reactor Accident Dynamics[1]

Water-Lubricated Bearing Studies, by *Abraham Smaardyk*, Argonne National Laboratory (Paper No. 55—SA-42)

A Package Power-Plant Reactor for Remote Areas[1]

2:30 p.m.

Fuels (II)

Flame Geometry as a Factor in Industrial Heat Processing, by *R. C. LeMay*, Selas Corp. of America (Paper No. 55—SA-10)

Low-Frequency Oscillations in a Flame-Filled Tube, by *A. A. Putnam* and *W. R. Dennis*, Battelle Memorial Institute (Paper No. 55—SA-48)

2:30 p.m.

Fluid Meters

A Survey of Mass-Flow Measuring Principles[1]

New Schemes for Measuring Pulsating Flow With Head-Type Meters[1]

2:30 p.m.

American Rocket Society (I)

Measurement of Rocket Thrust and Internal Pressure During Static Testing With High-Frequency-Response Instrumentation, by *Jack Buchanan*, Thiokol Chemical Corp.

Combustion Time-Lag Measurements in a Liquid Bipropellant Rocket Motor, by *Jerry Grey, Luigi Crocco*, and *George Matthews*, Princeton University

Vibration and Stress Analysis of Turbine Blades, by *Clarence Danforth*, General Electric Co.

A New Helium-Refrigerated System for Production and Storage of Low-Boiling Propellants, by *Alexis Pastuhov* and *C. Lincoln Jewett*, Arthur D. Little, Inc.

4:00 p.m.

Inspection Trip

Arthur D. Little, Inc., Cambridge, Mass.

7:00 p.m.

American Rocket Society Dinner

8:00 p.m.

Junior (II)

Speaker: *Nathan Nichols*, Raytheon Manufacturing Co.

Speaker: *J. Herbert Hollomon*, General Electric Co.

Subject: **The Engineer in Research**

THURSDAY, JUNE 23

8:00 a.m.

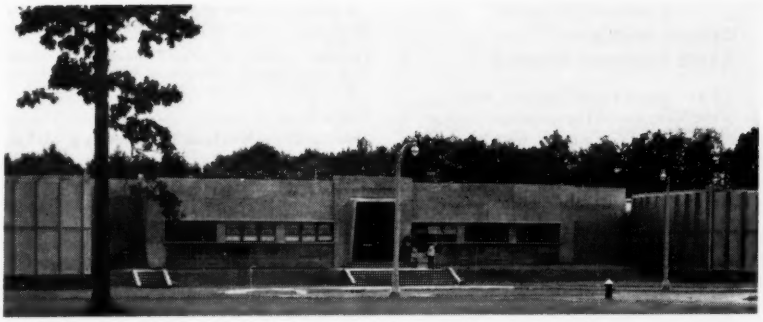
Registration

9:30 a.m.

Aviation (I)—American Rocket Society (II)

A Survey of Aerodynamic Excitation Problems in Turbomachines, by *A. Sabatiuk* and *F. Sisto*, Curtiss-Wright Corp. (Paper No. 55—SA-40)

A Practical Approach to the Problem of Stall Flutter[1]



Quartermaster Research and Development Center Climatic Building, Natick, Mass., which houses the Arctic and Tropic Climatic Chambers and the specialized equipment of the Environmental Protection Division, is unique among research installations. An inspection trip is scheduled during ASME Diamond Jubilee Semi-Annual Meeting, June 19–23, to be held at the Hotel Statler.

ASME National Nominations

THE 1955 Nominating Committee is to meet for two days, June 20-21, 1955, at the Hotel Statler in Boston, Mass., where the Semi-Annual Meeting will be held. Open hearings will be held so that members may speak in behalf of their candidates for the office of President, Regional Vice-Presidents, and Directors any time between the hours of 10:30 a.m. to 12 noon; and from 2 p.m. to 5 p.m. on Monday, June 20, and on Tuesday, June 21, from 9:30 a.m. to 12 noon and, if necessary, from 2 p.m. to 5 p.m. Following the close of business of the 1955 Nominating Committee, there will be held an Organization Meeting of the 1956 Committee presided over by E. W. Allardt, chairman of the 1955 Committee. This meeting will take place on Tuesday afternoon or evening, June 21, following the Business Meeting of the 1955 Committee or, if necessary to extend the Business Meeting through Tuesday evening, the Organization Meeting will be held on Wednesday morning, June 22.

[1] Preprints not available—see box on page 460.

Official Notice—ASME Business Meeting

THE Semi-Annual Business Meeting of the Members of The American Society of Mechanical Engineers will be held Monday, June 20, 1955, at 4:45 p.m., Hotel Statler, Boston, Mass., as part of the Diamond Jubilee Semi-Annual Meeting.

The program is planned to include the announcements of the location of the 1956 Semi-Annual Meeting and election of the Nominating Committee for 1956.

This Business Meeting of the Members provides an opportunity for a free discussion of Society policies and procedures and all Members are urged to attend. President Morgan will preside.

9:30 a.m.

Machine Design (II)

On the Maximum and Minimum Velocities and the Accelerations in Four-Link Mechanisms, by *Ferdinand Freudenstein,* Columbia University (Paper No. 55—SA-20)

The Effect of Bearings on the Dynamics of Overhung Turbines, by *C. J. Maday,* 9365th TSU, Rossford Ordnance Depot, formerly Illinois Institute of Technology (Paper No. 55—SA-16)

9:30 a.m.

Textile Engineering (I)

Crimping Filament Yarn by the Ban-Lon Process[1]

Tas-Lan Textured Yarns[1]

9:30 a.m.

Production Engineering (IV)—Metal Processing (IV)

On the Tool-Life and Temperature Relationship in Metal Cutting, by *Edward Saibel* and *F. F. Ling,* Carnegie Institute of Technology (Paper No. 55—SA-23)

The Nature of Wear of Cemented-Carbide Tools, by *K. J. Trigger* and *B. T. Chao,* University of Illinois (Paper No. 55—SA-11)

Chatter Vibration of Lathe Tools[2] by *S. Doi* and *S. Kato,* Nagoya University, Furo-cho, Chikusaku, Nagoya, Japan (Paper No. 55—SA-22)

9:30 a.m.

Safety (I)—Nuclear Engineering (III)

Nuclear Energy

Boiling-Reactor Safety Considerations[1]

Safety Aspects in Development of University of Michigan Reactor[1]

9:30 a.m.

Fuels (III)—Power (V)

Coal and Ash Handling—Martins Creek Steam-Electric Station, by *W. H. Kopenhaver,* Pennsylvania Power & Light Co. (Paper No. 55—SA-46)

Coal and Ash-Handling Problems in Small Plants, by *Donald M. Given* and *Carl A. Marshall,* Fairmont Coal Bureau (Paper No. 55—SA-47)

9:30 a.m.

Gas Turbine Power (I)

Some Aerodynamic Investigations in Radial-Flow Centrifugal Impellers[1]

A Three-Dimensional Spherical Pitot Probe[1]

Combustion of Liquid-Fuel Drops[1]

12:00 noon

Inspection Trip

General Electric River Works, West Lynn, Mass.

12:15 p.m.

Textile Engineering Luncheon

Presiding: *Leslie A. Runton,* chairman, ASME Textile Engineering Division; Alexander Smith Carpet Co., Yonkers, N. Y.

Speaker: *Steven S. Marks,* textile editor, *Daily News Record,* Fairchild Publications, New York, N. Y.

Subject: **An Editor Looks at the Textile Industry**

2:30 p.m.

Aviation (II)—American Rocket Society (III)

The Flow in a Vee-Gutter Cascade[1]

Determination of Mach Number From Pressure Measurements, by *F. W. Barry,* United Aircraft Corp. (Paper No. 55—SA-28)

[1] Preprints not available—see box on page 460.

[2] Presented by title only.

2:30 p.m.

Machine Design (III)

Long Shoe-Block Brake With Floating Anchor, by *M. F. Spotts,* Northwestern University (Paper No. 55—SA-21)

Determination of Radius of Curvature for Radial and Swinging Follower Cam Systems, by *Martin Kloomok* and *R. V. Muffley,* International Business Machines (Paper No. 55—SA-29)

Determination of Pressure Angles for Swinging Follower Cam Systems, by *Martin Kloomok* and *R. V. Muffley,* International Business Machines (Paper No. 55—SA-38)

2:30 p.m.

Textile Engineering (II)

Engineering Aspects of Textile Structures[1]

2:30 p.m.

Production Engineering (V)

Study of Die Wear by Means of Radio-Activated Surfaces, by *Bernard Jaoul,* University of Pittsburgh (Paper No. 55—SA-24)

Applications of Thread and Form Rolling, by *C. T. Appleton,* Reed Rolled Thread Die Co. (Paper No. 55—SA-7)

2:30 p.m.

Safety (II)—Management (IV)

The Safe Plant

Effective Management Controls Accidents, by *A. S. Johnson,* American Mutual Liability Insurance Co. (Paper No. 55—SA-30)

Applying Research to Accident Prevention, by *A. L. Brown,* Associated Factory Mutual Fire Insurance Companies (Paper No. 55—SA-32)

Designing the Safe Factory, by *R. T. VanNess,* E. I. du Pont de Nemours & Co., Inc. (Paper No. 55—SA-31)

2:30 p.m.

Gas Turbine Power (II)

The Aerothermopressor—A Device for Improving the Performance of a Gas-Turbine Power Plant[1]

8:00 p.m.

American Rocket Society (IV)

Stabilization of Low-Frequency Oscillation of Liquid Rockets and Fuel-Line Stabilizers, by *Y. T. Li,* Massachusetts Institute of Technology

Further Studies on the Effects of an Opposing Jet on Flame Stability, by *Edward Pohlmann* and *Ali Bulent Cambel,* Northwestern University

A film will be shown on "ROR Helicopter" (Rocket Powered Helicopter) from Reaction Motors, Inc., Rockaway, N. J.

FRIDAY, JUNE 24

9:00 a.m.

Inspection Trip

Wyman-Gordon Co., North Grafton, Mass.

5:00 p.m.

Clambake

WOMEN'S PROGRAM

Sunday, June 19

4:30–7:30 p.m. Social Hour

Monday, June 20

9:00 a.m.	Registration and Coffee
Noon	President's Luncheon
Afternoon	Tour of historic Boston
Evening	"Pops" Concert

Tuesday, June 21

Morning	Free for shopping, visiting, or sightseeing
Afternoon	Tea at the Gardner Museum
Evening	Banquet

Wednesday, June 22

All-day trips, including luncheon, with a choice between a trip to North Shore or one covering Concord, Lexington, Wayside Inn, and Sudbury, Mass.

Thursday, June 23

Day free for sight-seeing. Famous New England clambake planned for the evening. An old-fashioned clambake is to be held on the shores of

Members of the Planning Committee on the ASME Diamond Jubilee Semi-Annual Meeting to be held at the Hotel Statler, Boston, Mass., June 19–23. Seated, *left to right,* are: E. Barry, chairman, Entertainment; F. A. Stearns, Secretary; W. J. Alexander, committeeman, Boston Section; A. J. Feretti, General Chairman; W. Saunier, chairman, Finance; and H. King, Advisory Chairman of previous Boston meeting. Standing in the same order are: G. White, E. E. Mills, F. E. Reed, chairman, Publicity subcommittee; E. Giles, chairman, Printing and Signs; G. Westaway, chairman, Hotel subcommittee; and R. D. Sanborn, Assistant Secretary-Treasurer, Boston Section. Members who were not present include Kerr Atkinson, chairman, Reception; Richard Bessom, chairman, Plant Trips; Charles Crede, chairman, Technical Sessions; Floyd Dedrick, chairman, Boston Section; Theodore Graser, Secretary-Treasurer, Boston Section; Mrs. Theodore Graser, chairman, Woman's Auxiliary and Women's Activity Committee; Frank Gunby, Adviser; Alton Kirkpatrick, Edgar MacNaughton, and Francis Staszesky, chairman, Registration.

historic Plymouth Harbor, only five minutes' walk from Plymouth rock. The menu the whole family will enjoy includes lobster, steamed clams, corn, watermelon, and other ingredients of the "bake"—all this and ocean breezes and the atmosphere of this Pilgrim town.

Inspection Trips

Four inspection trips have been arranged. These include a visit to the Wyman-Gordon Company-USAF plant in North Grafton, Mass.; General Electric Company River Works, West Lynn, Mass.; Quartermaster Research and Development Center, Natick, Mass.; and the research laboratories of Arthur D. Little, Inc., West Cambridge, Mass.

At the Wyman-Gordon plant will be seen the 35,000-ton press, largest in the world now in production. This is the first of the heavy presses built under the USAF heavy-press program which was inaugurated in 1942. The press is hydraulically operated and was designed by the Loewy Construction Company of New York, N. Y.

The River Works plant is the birthplace of many G. E. operations. Here was located the Thompson-Houston Electric Company, started in 1883, which consolidated with Edison General Electric in 1892 to form the General Electric Company, with Charles A. Coffin of Lynn as the first G. E. president. At present the River Works provides headquarters for the Measurements and Industrial Products Division, comprising a Lighting and Rectifier Department and a Meter and Industrial Department, a large part of the Aircraft Gas Turbine Division, since American jet power began in the River Works, the Synchronous and Specialty Motor and Generator Department and the Medium Steam Turbine, Generator Department and the Medium Steam Turbine, Generator, and Gear Department.

The Quartermaster Research and Development Center provides the Quartermaster Corps with facilities to study soldiers' requirements and test equipment under simulated environments. Unique to this new Center is the Climatic Research Laboratory which contains an arctic and tropic chamber.

At the laboratories of Arthur D. Little, Inc., several exhibits will be viewed including a magnetic refrigerator, a new type of blood-processing machine, and a trailer-mounted two-ton-a-day liquid-oxygen plant. Also to be exhibited are some examples of chemical work such as paint brushes from chicken feathers and a self-locking bolt.

Program Announced for Oil and Gas Power Conference, Hotel Statler, Washington, D. C., June 6–9

Tentative Program

SUNDAY, JUNE 5

12:00 to 6:00 p.m. — **Mezzanine**

Registration

5:00 p.m. — **California Room**

OGP Executive Committee

MONDAY, JUNE 6, 1955

8:00 a.m. — **Ohio Room**

Authors' Breakfast

9:00 a.m. to 5:00 p.m. — **Mezzanine Room**

Registration

9:00 a.m. to 6:00 p.m. — **Exhibit Area**

Exhibit Open

9:30 a.m. — **Presidential Ballroom**

Technical Session 1

Chairman: *Capt. Howard Stoner*, USN, Bureau of Ships, Navy Department

Vice-Chairman: *Karl W. Stinson*, Ohio State University

A High-Speed Lightweight Opposed Piston Engine for Navy Application, by *A. K. Antonsen*, supervisor, research engineering department, Fairbanks Morse & Co.

Development of a Large Two-Cycle Gas Engine, by *Eric Brater*, assistant chief engineer, Cleveland Diesel Engine Division, General Motors Corp.

11:45 a.m. — **Exhibit Area**

Exhibitors' Social Hour (Ladies Invited)

12:30 p.m. — **South American Room**

Welcome Luncheon (Ladies Invited)

Speaker: *Vice Adm. Roscoe F. Good*, USN, U. S. Navy, Deputy Chief Naval Operations (Logistics)

Subject: **Power Trends in the Navy**

Toastmaster: *Charles G. Cooper*, vice-president, Cooper-Bessemer Corp., Presentation of OGP Citations for Outstanding Service to: E. C. Magdeburger, formerly Bureau of Ships, Navy Department; Hugo H. Hass, formerly Bureau of Ships, Navy Department; and Jean Santchi, formerly Nordberg Manufacturing Co.; by Rear Admiral W. D. Leggett, Jr., USN (Ret.), vice-president, American Locomotive Co.

2:00 p.m. — **Presidential Ballroom**

Technical Session 2

Chairman: *John W. Sawyer*, Bureau of Ships, Navy Department

Vice-Chairman: *R. Tom Sawyer*, manager, research department, American Locomotive Co.

Gas Turbines for Ship Propulsion,[1] by *John McMullen*, U. S. Maritime Commission

Air Force Requirements for Diesel Engines, by *Col. J. S. Bleymaier*, Air Research and Development Command, U. S. Air Force

8:00 p.m. — **Presidential Ballroom**

General Technical Committee Meeting (Open to all)

Discussion of Government Specifications for Purchase of Internal-Combustion Engines

Chairman: *Capt. Richard Mandelkorn*, USN, Bureau of Ships, Navy Department

Vice-Chairman: *James C. Barnaby*, consulting engineer, Worthington Corp.

Moderator: *Carl H. Giroux*, special assistant, Office of the Chief of Engineers, U. S. Army

Panel Members: Col. W. D. Alexander, U. S. Air Force, Engineering Division; *George J. Cleary*, U. S. Air Force, Engineering Division; *Laskar Wechsler*, Bureau of Ships, Navy Department; *R. W. Beal*, Engineering Research and Development Laboratory, Fort Belvoir, Va.; *F. A. Bennett*, Bureau Yards and Docks, Navy Department; *Leroy Deming*, Bureau Yards and Docks, Navy Department; and *K. R. Nisbet*, Military Construction Division, Corps of Engineers

TUESDAY, JUNE 7

8:00 a.m. — **Ohio Room**

Authors' Breakfast

9:00 a.m. to 5:00 p.m. — **Mezzanine**

Registration

9:00 a.m. to 7:00 p.m. — **Exhibit Area**

Exhibit Open

9:30 a.m. — **Presidential Ballroom**

[1] Cosponsored by the Gas Turbine Division.

Technical Session 3

Chairman: *John C. Gibb*, staff engineer, Socony-Vacuum Oil Co.

Vice-Chairman: *Brian Corrigan*, mechanical engineer, The Texas Co.

Fuels for U. S. Navy Gas Turbines,[1] by *H. F. King*, Bureau of Ships, Navy Department, and *H. V. Nutt*, U. S. Naval Engineering Experiment Station

Panel Discussion on Heavy Fuels

Moderator: *Capt. "Clay" Latrobe*, USN, supervisor of Shipbuilding, Baltimore, Md.

Panel Members: Judson L. Philips, Esso Research Engineering Co.; *E. D. Rawlins*, Cooper-Bessemer Corp.; *George V. Neely*, Standard Oil Company of California; and *Capt. M. M. Dana*, USN (Ret.), University of North Carolina

12:00 p.m. — **Ohio Room**

Power Cost Committee Luncheon

2:00 p.m. — **Presidential Ballroom**

Technical Session 4

Chairman: *Rear Adm. W. D. Leggett, Jr.*, USN (Ret.), vice-president, American Locomotive Co. Vice-Chairman: *T. M. Robie*, administrative engineer, Fairbanks, Morse & Co.

Standardization of Marine Diesel Engines, by *Capt. Carl A. Peterson*, USN, director, U. S. Naval Engineering Station, and *Lieut. Cmdr. Wilfred M. Howerton*, USN, Bureau of Ships, Navy Department

Panel Discussion on Mobilization of the Oil and Gas-Engine Industry

Moderator: *Capt. Peter H. Horn*, USN, Bureau of Ships, Navy Department

Panel Members: Frank Mason, Fairbanks, Morse & Co.; and *E. W. Hand*, Business Defense Service Administration, Department of Commerce

6:00 p.m. — **Exhibit Area**

Exhibitors' Social Hour (Ladies Invited)

6:30 p.m. — **Continental Room**

Reception for Honored Guests (By Invitation)

7:00 p.m. — **Presidential Ballroom**

Dinner—Dress Informal (Ladies Invited)

Introductions: *John A. Worthington*, chairman OGP Division, ASME

Toastmaster: *Thomas E. Hughes*, general manager, Cleveland Diesel Division: General Motors Corp.; and president, Diesel Engine Manufacturers Association. Presentation of OGP Awards and Honors to: John A. Worthington, Koppers, Co., Inc.; Prof. A. Wiley Sherwood, for Washington, D. C., Section, ASME; Edward A. Sammis, Sperry Gyroscope Co.; J. E. Hart, Kaiser Aluminum and Chemical Corp.; John C. Gibb, Socony-Vacuum Oil Co., Inc.; Lewis F. Moody, Jr., Socony-Vacuum Oil Co., Inc., Carlton A. Chamberlain, Clark Bros. Co.; and T. H. Pofahl, El Paso Natural Gas Co.; by Sidney E. Miller, vice-president, The American Bosch Arma Corp.

Speaker: *D. W. R. Morgan*, ASME President and vice-president, Westinghouse Electric Corp.

Speaker: To be announced

Subject: **Oil and Gas Power for National Defense**

WEDNESDAY, JUNE 8

8:00 a.m. — **Ohio Room**

Authors' Breakfast

9:00 a.m. to 5:00 p.m. — **Mezzanine**

Registration

9:00 a.m. to 5:00 p.m. — **Exhibit Area**

Exhibit Open

9:30 a.m. — **Federal Room**

Technical Session 5

Chairman: *John Pennington*, Koppers Co., Inc. Vice-Chairman: *Wallace Newcomb*, Ingersoll-Rand Co.

Analysis of Development Trends in Industrial Diesel Power Units, by *C. G. A. Rosen*, consulting engineer, Caterpillar Tractor Co., and president, Society of Automotive Engineers

Aerothermodynamics Considerations Involved in Turbocharging Four and Two-Cycle Diesel Engines, by *Rudolph Birmann*, consulting engineer, De Laval Steam Turbine Co.

11:45 a.m. **Exhibit Area**

Exhibitors' Social Hour (Ladies Invited)

2:00 p.m. **Federal Room**

Technical Session 6

Chairman: *George J. Dashefsky*, Naval Material Laboratory, N. Y. Naval Shipyard

Vice-Chairman: *H. J. Henry*, chief engineer, Chicago Pneumatic Tool Co.

The Comparison of the Fatigue Characteristics of New and Used Crankshafts, by *Joseph L. Ciringione*, Naval Material Laboratory, N. Y. Naval Shipyard

Analysis of the Basic Noise Sources in the Diesel Engine, by *Kenneth R. Mercy*, Naval Material Laboratory, N. Y. Naval Shipyard.

8:00 p.m. **Federal Room**

Special Lecture

THURSDAY, JUNE 9

8:00 a.m. **Ohio Room**

Authors' Breakfast

9:00 a.m. to 2:00 p.m. **Mezzanine**

Registration

9:00 a.m. to 2:00 p.m. **Exhibit Area**

Exhibit Open

9:30 a.m. **Federal Room**

Technical Session 7

Chairman: *Lee Townsend*, engineer, Wm. Nugent & Co.

Vice-Chairman: *Edmond Frederick*, assistant chief engineer, Cooper-Bessemer Corp.

The Preparation of Residual Fuel for Motive Power, by *F. H. Smith*, Sharples Corp.

Cetane Improver Additives for Diesel Fuels, by *W. H. Hubner*, Ethyl Corp.

2:00 p.m.

Technical Session 8

Chairman: *S. E. Miller*, vice-president, American Bosch, Arma Corp.

Vice-Chairman: *Robert Cramer*, assistant chief engineer, Nordberg Manufacturing Co.

Effect of Size on the Inlet System Dynamics in Four-Stroke-Single-Cylinder Engines, by *D. H. Tsai*, Engines and Lubrication Section, U. S. Department of Commerce

The Philosophy of Vee-Engine Design, by *Ralph L. Boyer*, and *John W. Holmes*, both of Cooper-Bessemer Corp.

5:30 p.m.

OGP Executive Committee Meeting

ASME Boiler and Pressure Vessel Committee Meeting, San Francisco, June 20–24

A MEETING of the Boiler and Pressure Vessel Committee of The American Society of Mechanical Engineers will be held jointly with the National Board of Boiler and Pressure Vessel Inspectors June 20–24, inclusive, at the St. Francis Hotel, San Francisco, Calif.

The meeting will include a panel session on all the various sections of the ASME Boiler and Pressure Vessel Code which will cover, in part, power boilers, unfired pressure vessels, heating boilers, and welding requirements. Meetings of the subcommittees also are planned.

A cocktail party and banquet will be held on Wednesday, June 22, and the all-day session of the Boiler and Pressure Vessel Committee is planned for Thursday. The schedule for Friday lists a choice of either a plant inspection or sight-seeing trips.

The San Francisco Section and the local representatives of the National Board of Boiler and Pressure Vessel Inspectors comprise the Planning Committee.

The Boiler and Pressure Vessel Committee holds seven meetings a year, one of which is held out of New York, N. Y.

Dana Young Is Appointed Dean of Yale Engineering

DANA YOUNG, Mem. ASME, Sterling Professor of Civil Engineering, has been appointed dean of the Yale School of Engineering.

Dr. Young, who will assume his new duties July 1, will succeed Walter J. Wohlenberg, Fellow ASME, who has served since 1948 and is retiring to devote his full time to teaching and research.

Dr. Young is chairman of the Civil-Engineering Department. He was graduated with a BS degree from Yale in 1926 and received his MS from Yale in 1930. He was awarded his PhD in engineering mechanics by the University of Michigan in 1940. He has been employed in industry and has taught at Yale as well as at the University of Connecticut and at the University of Texas. During World War II he was a research engineer in the University of Texas defense research laboratory and also worked on war research in the Johns Hopkins Laboratory of Applied Physics.

He was chairman of the Executive Committee of the ASME Applied Mechanics Division in 1953.

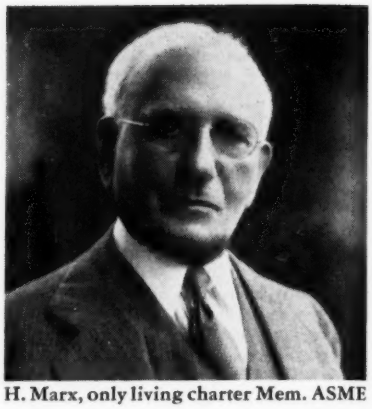
Henry Marx, Charter Mem. ASME, Honored

HENRY MARX, only living Charter Mem. ASME, and president G. A. Gray Company, was honored at a special meeting of the Cincinnati Section on March 20. Mr. Marx was awarded a medal in recognition of his 75-year membership in the Society.

Mr. Marx was unable to be present at the meeting; his brother, August Marx, received the award on his behalf. The presentation was made by David W. R. Morgan, ASME President. A citation honoring Mr. Marx was presented, by Walter Tangeman, Mem. ASME, executive vice-president, Cincinnati Milling Machine Company.

The citation in part reads as follows: "The National Board of Directors of The American Society of Mechanical Engineers is honored to present its Distinguished Service Award to Henry Marx, Charter Member of ASME, in recognition of his 75 years of service.

"Mr. Marx is the only living member of the group of engineers who, in the year 1880, established The American Society of Mechanical Engineers. It is to this group that we owe the benefits that have come since then to engineers, to engineering, and to society as a whole from the many-fold activities of ASME. The foresight of this group, in consolidating professional interests by establishment of ASME, has contributed most significantly to the present dignity and solidarity of Mechanical Engineering as a profession."



H. Marx, only living charter Mem. ASME

ASME Calendar of Coming Events

June 5–10
ASME Oil and Gas Power Conference, Hotel Statler, Washington, D. C.
(Final date for submitting papers was Feb. 1, 1955)

June 15–17
ASME and The Institution of Mechanical Engineers, London, England, Joint Conference on Combustion, Massachusetts Institute of Technology, Cambridge, Mass.
(Final date for submitting invited papers was Nov. 1, 1954)

June 16–18
ASME Applied Mechanics Conference, Rensselaer Polytechnic Institute, Troy, N. Y.
(Final date for submitting papers was Feb. 1, 1955)

June 19–23
Diamond Jubilee Semi-Annual Meeting, Hotel Statler, Boston, Mass.
(Final date for submitting papers was Feb. 1, 1955)

June 20–24
ASME Boiler and Pressure Vessel Committee Out-of-Town Meeting held jointly with the National Board of Boiler and Pressure Vessel Inspectors, St. Francis Hotel, San Francisco, Calif.

Sept. 12–14
West Coast Committee of the ASME Applied Mechanics Division, 1955 Western Conference on Applied Mechanics, U. S. Naval Post-Graduate School, Monterey, Calif.
(Final date for submitting papers was May 1, 1955)

Sept. 12–16
ASME Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Los Angeles, Calif.
(Final date for submitting papers was May 1, 1955)

Sept. 25–28
ASME Petroleum-Mechanical Engineering Conference, Roosevelt Hotel, New Orleans, La.
(Final date for submitting papers was May 1, 1955)

Oct. 10–12
ASME-ASLE Second Lubrication Conference, Antlers Hotel, Indianapolis, Ind.
(Final date for submitting papers—June 1, 1955)

Oct. 19–20
ASME-AIME Joint Fuels Conference, Neil House, Columbus, Ohio
(Final date for submitting papers—June 1, 1955)

Nov. 13–18
Diamond Jubilee Annual Meeting, Hotel Congress, Chicago, Ill.
(Final date for submitting papers—July 1, 1955)

Nov. 14–18
Exposition of Power and Mechanical Engineering, as part of ASME 75th Anniversary Annual Meeting, Coliseum, Chicago, Ill.
(For Meetings of Other Societies see page 474)

Shown, *left to right,* are John Haydock, chairman, Executive Committee, ASME Machine Design Division; Thorndike Saville, Dean of NYU's College of Engineering; and Prof. A. H. Church, chairman, mechanical-engineering department, NYU, chatting at the ASME Machine Design Conference

Designing for Production Discussed at ASME Machine Design Conference

Maintaining product quality while cutting design costs stressed

PROBLEMS of preparing for automation and increased industrial competition were discussed on April 16 at New York University by the nation's leading machine-design engineers.

Nearly 200 engineers attended the 1955 conference of the Machine Design Division of The American Society of Mechanical Engineers. The meeting was held in conjunction with the 75th anniversary of ASME and the 100th anniversary of the NYU College of Engineering. The ASME Metropolitan Section also co-operated in the program.

Seven technical papers were presented during the full-day conference and Thorndike Saville, dean of engineering, addressed the luncheon session on the subject "Early Engineering Education in the United States."

Morning Panel

Leading off the morning panel, a blueprint for the next chapter in industrial automation was outlined by W. C. Allen, director of manufacturing and equipment engineering of the Westinghouse Electric Corporation, Pittsburgh, Pa.

Mr. Allen said that automation is already under way. Machines are now operated automatically, he pointed out, but the human operator still has to load, unload, and start the cycle.

"The task ahead," he added, "lies in our ability to develop and apply mechanisms to control automatically, feed, adjust, measure, and repeat cycles without manual effort."

Mr. Allen listed as some requirements: Automatic positioning and clamping devices; a built-in demand system for preloading; automatic gaging devices to control the operation and interrupt or terminate the cycle; automatic ejection of defective parts by the machine; signal devices for tool changes; provisions for detours or stock-piling to allow for emergencies without a shutdown; safety-control devices and warning systems to signal trouble; automatic lubrication; and data-processing machines to control information centers that, by tape or punch card, feed in instructions for workpiece and cutting-tool movements.

"Before these requirements can be met," Mr. Allen said, "there must be a readjustment of philosophy throughout industry." The machine-tool industry, manufacturers, and the electrical-control industry, he stated, must work as a team.

Designing for production, according to J. H. Conard, Chandler-Evans Division, Niles-Bement-Pond Company, West Hartford, Conn., is the design of a product to enable its production at a minimum competitive cost while maintaining its operational and field-service requirements.

To achieve this goal of a minimum competitive cost, he said, we must consider every detail of design, including a complete analysis of configuration, materials, surface finishes, and methods and tooling. Each of these considerations must include the interplay of one upon the other, he added.

Mr. Conard asked: How can we resolve the problems of designing for production? How can we assure ourselves of a complete analysis of these production considerations?

The individual engineer must be depended upon, he said, for, in the last analysis, he does the designing. However, much can be done by the supervisor and by management to help the individual do his job better.

The principal tools with which supervision or management can assist its engineers to design for production, according to Mr. Conard, are organization, simplification, and standardization, experimentation, and education. These are tested tools, which, when properly used, will result in sound production designs.

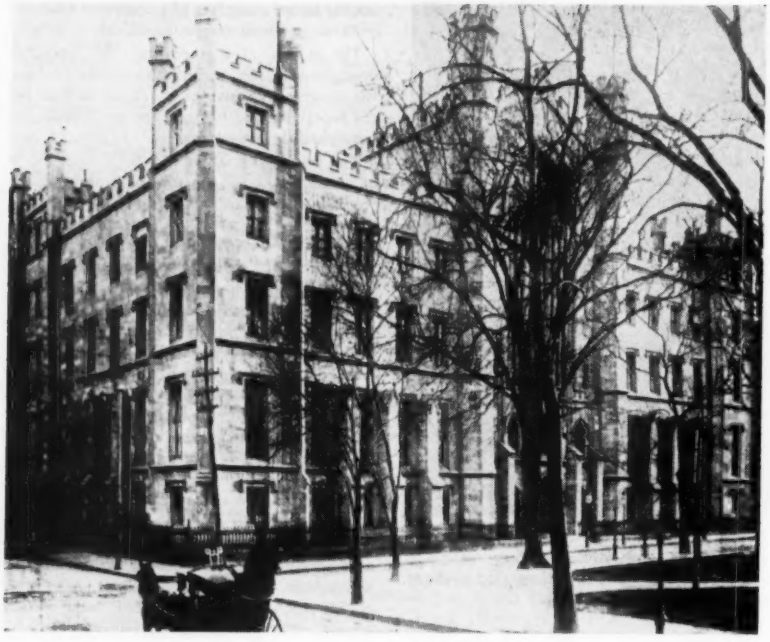
Stressing standardization programs, Mr. Conard pointed out that standardization of drafting practices releases the designer of much detail work, putting such work on a routine basis, easily understood by the detail draftsman. Then, too, many modern drafting standards, such as "true position dimensioning," are directly related to known methods of manufacture or measurement. Such standards, therefore, lead to a more producible design.

The constant struggle to meet the customer's demand for higher quality at lower cost can be met only through new developments and improvements of existing equipment, according to H. Michelsen, Mem. ASME, master mechanic, New Departure Division, General Motors Corporation, Bristol, Conn. For many years, he said, New Departure has designed and built certain types of equipment for its own use because the equipment commercially available was not always suited for highly specialized operations. It was designed for the most part for universal application for various industries. In recent years, however, machine-tool builders have leaned closer to industries' requirements. This is especially so with regard to chucking and loading devices in connection with automation. In his paper Mr. Michelsen dealt with design of such equipment for the production of ball bearings. The major phases in ball-bearing inner and outer-ring manufacture, in the proper sequence, are as follows: Forging or machining from bars or tubing, machining on chuckers, heat-treatment, grinding and automatic gaging, honing, washing, and assembly.

Generally speaking, Mr. Michelsen stated, we always think of high-production equipment to reduce cost of the product. However, in the ball-bearing industry a great number of bearings are produced in small quantities. To devise equipment for the New Departure Precision Department where bearings for machine tools and aircraft are produced in comparatively small volumes, many problems are presented to the designer. This equipment, he said, must be designed for quick change-overs; it must be extremely accurate and fast; and, although it is manually loaded, it must be cycled automatically so that one operator can run several machines.

With the advent of automation there is now a tendency for industrial users to sacrifice styling and place more emphasis on machine performance, work handling, safety, and maintenance, declared B. D. Smith, Mem. ASME, general supervisor of mechanical-engineering research for International Harvester Company of Chicago, Ill.

(*Continued on page 468*)

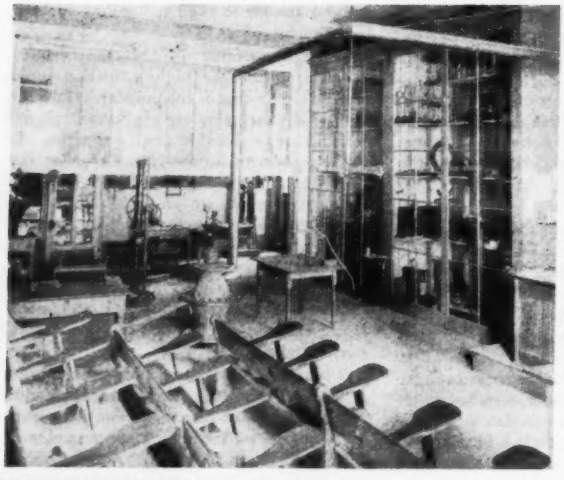


New York University's College of Engineering was born in this building, located at Washington Square in New York City. Classes in the "School of Civil Engineering and Architecture" began here in 1854. Its founders saw it as a place where young men could be trained to be, among other things, "mechanics, architects, or civil engineers." In 1894 the University moved to Morris Heights, a 43-acre site in the Bronx. Although many divisions of the University later moved back to Manhattan from the Bronx, the engineering school and a college of liberal arts have remained. The campus, known today as "University Heights," is dominated by the dome of Gould Memorial Library and its colonnade, which contain the Hall of Fame for Great Americans. In 1899 the name "School of Applied Science" was adopted. In 1920 the College took its present name.

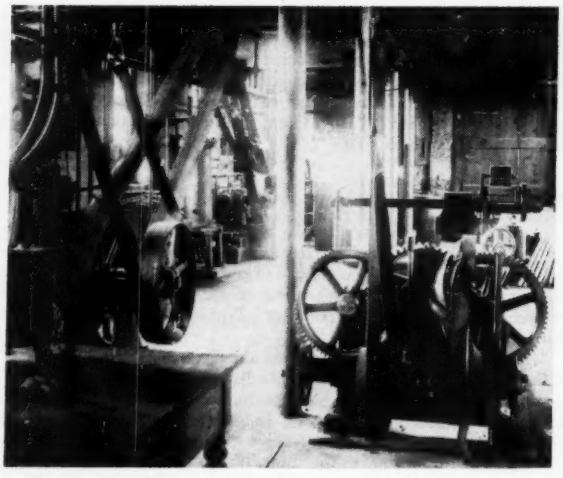
100 YEARS OF ENGINEERING

"Teaching and Research Build the Future"

NYU's College of Engineering Centennial Theme

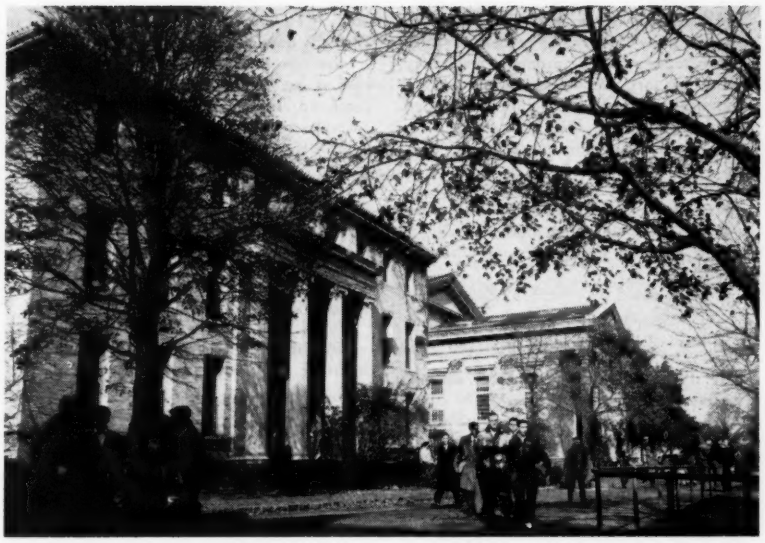


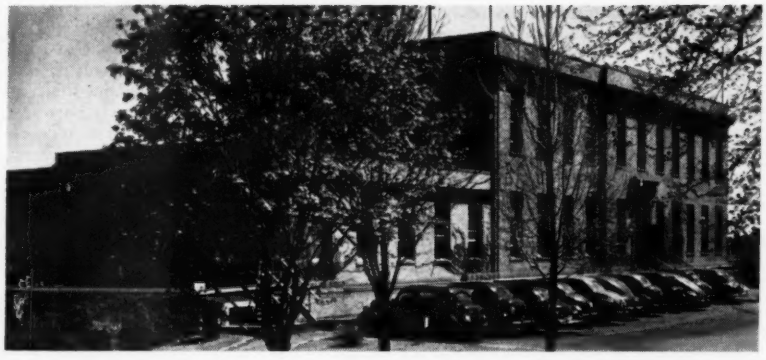
This physics laboratory was used by students in NYU's College of Engineering about 1885. Room is same in which Samuel F. B. Morse did first experiments on recording telegraph with a student, Alfred Vail.



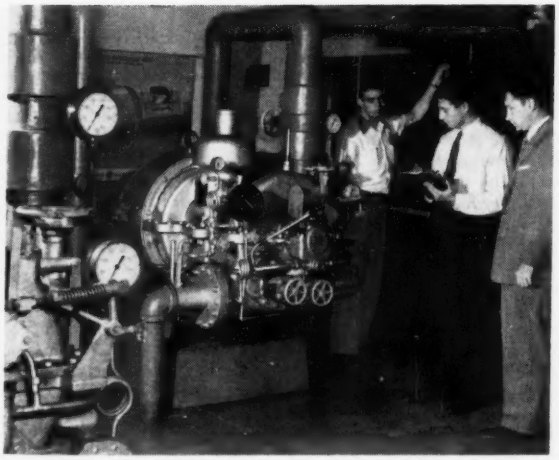
Mechanical engineering at NYU—nineteenth-century style—is shown in this view of an old mechanical laboratory in the College of Engineering around 1900. In foreground is a torsion machine.

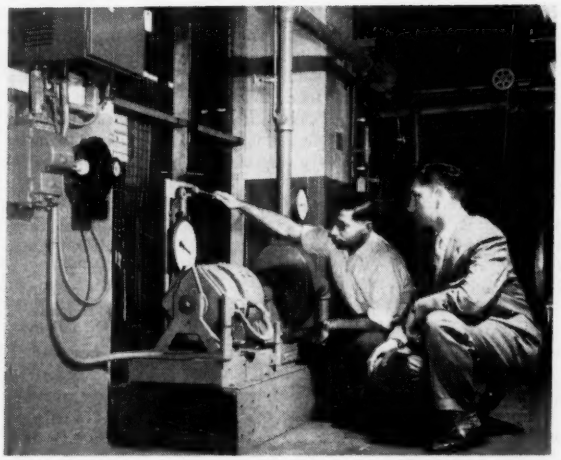
NYU Campus at University Heights today is occupied by the College of Arts and Sciences and the College of Engineering. Its Day Division rates twelfth in enrollment among the nation's undergraduate schools of engineering. The enrollment of its Graduate Division ranks fifth. Its Research Division, whose present annual dollar total is about $2,235,000, is the sixth largest university engineering-research center in the U. S. Among the advancements in engineering education pioneered by NYU was the establishment in 1926 of the first school of aeronautics at an American institution of higher learning, the Daniel Guggenheim School of Aeronautics.





Headquarters for Mechanical Engineering at NYU since 1910 has been the Sage Building. Research has played a major role in the ME department since its organization. Projects included a study of the structural problem of rockets and pilotless aircraft while in flight, and problems that arise in applied plasticity. A recent project was initiated to study the stresses within artillery shells.





Mechanical-Engineering Laboratory at NYU—1955 style—shows students running tests on a steam-turbine-generator unit, *left photo.* In *right photo,* a student and instructor are in the process of obtaining performance curves of characteristics of centrifugal pumps. A curriculum in Mechanical Engineering first appeared in the School of Applied Science Bulletin of 1899–1900. It departed from the CE course by adding two courses in thermodynamics and two in machinery.

Until recently, engineers and buyers insisted on streamlining and styling in machine tools. With increasing use of automatic machinery, he said, this inclination does not lend itself to economical and efficient machine-tool design.

This is but one of the implications of increased mechanization of industry, Mr. Smith stated. He also cited low production—production of parts in relatively small numbers. Designers of tomorrow's machines will have to build versatility into machines, he said, in order to amortize most expensive automatic machinery.

The paper noted that there is a definite need for improved machine tools and increased mechanization in the medium and lower-production manufacturing operations. In order to satisfy these needs, he emphasized, we must first overcome the problems which hinder mechanization, such as cost justification of equipment, low production, large manufacturing tolerances, variety of parts, and the natural reluctance of machine-tool builders in working out mechanization problems in limited-production areas.

In planning for mechanization, Mr. Smith suggested that the following improvements be built into manufacturing equipment: Versatility, automatic loading and unloading, automatic built-in inspection, automatic controls, chip disposal, and Joint Industry Conference Standards.

George F. Habach, executive engineer, Worthington Corporation, Harrison, N. J., and Gerard Fangemann, general manager, Spring Division, John Chatillon & Sons, were chairman and vice-chairman, respectively, at the morning panel.

Early Engineering Education

The first seed of engineering education in the United States was planted in 1802 with the founding of West Point, Thorndike Saville, NYU's dean of engineering, said in his luncheon address. Rensselaer's Polytechnic Institute was established in 1824 and Dean Saville called RPI the progenitor of engineering schools in this country. In 1832 NYU was chartered as a private institution and the faculty included Major David B. Douglas, a professor of natural philosophy and civil engineering. However, it was not until 1854 that NYU established a "School of Civil Engineering and Architecture." He pointed out that NYU has the oldest university engineering school in the country.

In 1845, he continued, Union College inaugurated a course in civil engineering. Harvard and Yale established scientific schools in 1847, and in 1851 Dartmouth also established a scientific school. The University of Michigan, in 1853, inaugurated a civil-engineering course and in 1861 Massachusetts Institute of Technology was founded.

The curriculums in those days, Dean Saville pointed out, were much alike and persisted well up into the 1880's. About that time mechanical engineering became a regular curriculum in the schools.

Reading excerpts from early school catalogs, Dean Saville noted that there were no requirements for admission in the old days and a degree was awarded after one to three years of study. He also pointed out that students in the early days received a greater amount of the humanities than they do today. This, he said, is due to the many new phases that have come up, thereby leaving less time for the social sciences.

John Haydock, Mem. ASME., editor *Metal Working*, was toastmaster. Mr. Haydock said that this was the first of a new series of conferences to be held by the Machine Design Division. The next conference is scheduled for April, 1956, in Worcester, Mass.

Afternoon Symposium

"Tooling-up" programs in most American industries are almost never of permanent nature, E. P. Bullard, 3rd, chief production engineer of Pratt & Whitney Aircraft Corporation of East Hartford, Conn., declared.

The need for selection, design, and procurement of many thousands of different machine tools and other mechanical equipment, he said, has risen tremendously with development of mass-production techniques. Such changes, whose costs account for a considerable proportion of the total national income, are almost never permanent because "our competitive" system demands that the final product be constantly improved and constantly reduced in cost.

In some cases, such as in the styling of automobile bodies, "there are strong indications that changes are sometimes made simply for their own sake, inasmuch as the public tends to become tired of an old product," Mr. Bullard said.

The more unskilled and semiskilled labor that is used, the greater the need for special tooling, he said.

Since design accounts for about 10 per cent of the cost of building a new tool, he pointed out, designers can make considerable savings in over-all costs by increased attention to traditional-design considerations.

He listed these as simplicity, actual use of equipment, adaptability to manufacture by general purpose rather than special equipment, economy in materials, and use of standard commercial elements and scrap material. Other considerations he cited are maximum use of standard dimensions, incorporation of simplified means of inspection in the part, and ease of handling and assembly.

Much unnecessary expense can be avoided, Mr. Bullard said, if the designer visualizes the manufacture of each part as he draws it. "Unusual shapes, such as ellipses, compound angles, and nonconventional forms, are almost always difficult and expensive to produce."

To consider the type of production for which his company must engineer, W. C. Cadwell of the Caterpillar Tractor Company, Peoria, Ill., pointed out that it is necessary to view a wide variety of products. Included in the product line are eight models of track-and-wheel-type tractors, eight basic engines, three motor graders, with a complete line of earth-moving equipment. To this list must be added a number of attachments optional with the equipment and finally down to units made to the customer's order. Thus the scope of production consideration is obviously wide from the designer's viewpoint in that a given design may be one of which the production may be in thousands per year, or it may be one of which only a small volume will be built, in which case even the engineering expense will approach the actual manufacturing cost.

To add one more important complication, he said, our service policy of "no orphans" results in a wide variation in quantity production. A part may start out at high or low qualities, increase to some peak level, and eventually, as a serviced noncurrent item, may be produced in relatively small quantities. Obviously, a designer in our business must give much consideration to production methods in such a program as outlined.

The first approach, he continued, should aptly come under the category of specialized personnel assigned the duties of studying and attempting to minimize the production problems by direct contact with engineering work in progress. Included in the group of personnel concerned are a number of metallurgists as well as those with specialized manufacturing background working directly in the several engineering departments of the company; additionally are working groups in purchasing and manufacturing departments with direct contacts in the engineering department for various phases of work.

In the second approach, Mr. Cadwell said, would be the compilation, distribution, and effective use of our several standards publications, universally used throughout the company. Such work is an extremely important function guiding designers in the most desirable, economical way to perpetuate proved design features.

A third important factor in production considerations, according to Mr. Cadwell, is somewhat in its infancy, although several years of age, and may be referred to as the guidance and benefits derived from statistical quality control used in manufacturing. Our use of this tool has grown rapidly in the past decade, but the obvious advantages to learning the true picture are more and more becoming guidance to design.

C. A. Jurgensen, Mem. ASME, vice-president of manufacturing, De Laval Steam Turbine Company of Trenton, N. J., emphasized that heavy machinery is seldom mass-produced. While there are instances where it may be made in large production quantities, he said, more often heavy machinery is built as a single machine or in very small production lots. Although a particular manufacturer may build a type of machinery in varying sizes, his operation may be complicated further by the production of other types in the same shop which may or may not be closely related. This situation, he indicated, creates a "two-headed" problem for the design engineer. First, he must know his product and how to apply it. Second, he must know manufacturing processes and facilities sufficiently well to insure economy of manufacture. The management of such a company is also confronted with a problem—high design and development cost to shop hours produced. How to keep this ratio to a minimum and build quality machinery at minimum cost is a problem that has a substantial percentage of its solution within the control of the engineering department. Mr. Jurgensen outlined the following production

considerations that determine good machine design: (1) Adhere to good drafting practice; (2) Design to an established system of fits, tolerances, and allowances; (3) Adhere to good casting and welding practice; (4) Specify surface-finish requirements; (5) Design for maximum utilization of parts; (6) Design for maximum utilization of existing jigs, fixtures, and patterns; (7) Design within the capacity of the shop's facilities; (8) Design with standard fastenings and fittings; (9) Design for ease of assembly and service.

C. Higbie Young, emeritus professor of The Cooper Union, New York, N. Y., acted as chairman. R. H. Nielson, president, Nielson Hydraulic Equipment, Inc., New York, N. Y., was vice-chairman.

Committees

Three committees of the Society were in charge of the presentation of the conference. The committees and their officers and personnel are as follows: *Machine Design Division Executive Committee*, John Haydock, chairman; R. M. Conklin, secretary; G. F. Habach, H. Sizer, and C. W. Besserer. *Metropolitan Section Executive Committee*, Dudley F. Phelps, chairman; H. F. Roemmele, secretary; R. E. Weber, Jr., treasurer; Sabin Crocker, G. R. Hahn, C. F. Kayan, U. A. Rothermel, R. W. Schubert, A. R. Weismantle, E. S. Bance, J. L. O'Neill, and G. B. Thom. *Conference Committee*, A. H. Church, chairman; H. C. R. Carlson, M. G. Fangemann, R. H. Nielsen, F. H. Posser, and H. Sizer.

Availability List for 1955 ASME Machine Design Conference

The papers on this list are available in separate copy form until Feb. 3, 1956. Please order only by paper *number;* otherwise the order will be returned. Copies may be purchased from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.; 25 cents per copy to ASME members; 50 cents to nonmembers.

Paper No.	*Title and Author*
55—MD-1	Production Considerations in Machine Design, by W. C. CADWELL
55—MD-2	Production Considerations in Machine Design, Effects of Design Upon the Manufacturing Cost of Machine Tools and Other Mechanical Elements, by E. P. BULLARD, 3RD
55—MD-3	Production Considerations in the Design of Heavy Machinery, by C. A. JURGENSEN
55—MD-4	Production Considerations in Machine Design, by W. C. ALLEN
55—MD-5	Designing for Production, Its Importance, Its Problems, and Suggested Solutions, by J. H. CONARD
55—MD-6	Production Considerations in Machine Design With Particular Reference to Such Products as Ball Bearings, by H. MICHELSEN
55—MD-7	Mechanizing Machine Tools for Diversified Production, by B. D. SMITH

C-A-M Section Celebrates ASME's Diamond Jubilee—Honors Members

D. W. R. Morgan speaks at event in Ohio Honoring E. W. Allardt and O. D. Treiber

ERNEST W. ALLARDT, Mem. ASME, whose service as chief engineer has contributed to the progress of The Babcock & Wilcox Company Tubular Products Division, Alliance, Ohio, was recognized on March 16, 1955, as the member who had done most to further the aims and objectives of the Canton-Alliance-Massillon Section of The American Society of Mechanical Engineers.

Mr. Allardt, credited with being responsible for the establishment of the C-A-M Section, received the ASME 75th Anniversary Award, as the principal feature of "Ernie Allardt Night" which had been proclaimed by Harley R. Ewing, Mayor of Alliance, in co-operation with the Society.

More than 100 engineers, their wives, and guests gathered at Elks Glamorgan for the event. David W. R. Morgan, ASME President, made the presentation of the award. The Award is to be duplicated in each Section of the ASME across the country as the principal distinction available to members during the Diamond Jubilee Year.

Pays Tribute to Profession

Mr. Allardt, who became a member of ASME in 1926, got his engineering start with the U. S. Ordnance Department and the U. S. Naval Gun Factory in Washington, D. C., 1918–1921. He has been chief engineer of B&W Tube since the Alliance plant was established in 1942. In presenting the award Dr. Morgan hailed Mr. Allardt for his contributions to the Society and his "valued service in advancing the engineering profession."

In accepting the award Mr. Allardt pointed out that his company encourages professional and civic participation and that "every man owes something to the upbuilding of his profession."

Greetings were extended by Mayor Ewing; Ernest Theiss of Akron, a past vice-president of ASME; and William Cracknell, vice-president of the Alliance Kiwanis Club of which Mr. Allardt is past-president.

O. D. Treiber Honored

O. D. Treiber, consulting engineer, The Hercules Motors Corporation in Canton, also was honored. He received Fellow-grade membership in ASME for his contributions to engineering. This presentation was made by Mr. Allardt, who called it "belated" recognition. Mr. Treiber was hailed particularly for his work in the early development of diesel engines.

Looks to Future

Dr. Morgan, who was introduced by R. L. Hollaway, Jr., chairman of the C-A-M Section, gave a fascinating talk on "The History of ASME and Engineering Education."

Harking back to 1880, when ASME was established, Dr. Morgan pointed out that at that time few would have envisioned the scientific and engineering achievements that have been evolved in the intervening period. He then peered into the future, predicting that "there is no limit to the human ingenuity and American capacity to want and consume" and that richer living and sustained national growth are assured for Americans on two conditions: First, that there is no world war, and second, that the American free economy is preserved.

Dr. Morgan called for the removal of government from business and for the support by the American people of measures that will enhance the use of natural resources. In that connection he stressed the need for the education of more young Americans in the engineering field, pointing out that this year the Russians are turning out 50,000 engineers and 300,000 technicians, far in excess of the number being educated in this country. He opposed the induction of trained American technicians "helter skelter" into the Armed Services and emphasized the need for Americans to understand their economic system which "is a good one."

Award Will Honor Memory of Sperry

To commemorate the life and achievements of Elmer A. Sperry an award was announced by David W. R. Morgan, ASME President.

"Dr. Sperry, of gyroscopic fame, was one of America's great inventors," Mr. Morgan said. "Through more than 400 patents he was responsible for some of this country's most important peacetime and wartime discoveries and engineering advances. His genius and perseverance increased the facilities and safety of many types of transportation."

The Elmer A. Sperry Award has been made possible by Dr. Sperry's daughter, Mrs. Robert Brooke Lea, and his son, Elmer A. Sperry, Jr. The Society will administer the award fund.

The award comprises a medal, certificate, biography of Dr. Sperry by Jerome C. Hunsaker, and an honorarium. It will be given for "a distinguished engineering contribution which, through application proved in actual service, has advanced the art of transportation whether by land, sea, or air."

It may be made to an individual or a group. The winner will be chosen by a board representing The American Society of Mechanical Engineers, American Institute of Electrical Engineers, Society of Automotive Engineers, and Society of Naval Architects and Marine Engineers. The first award will be conferred this fall. Dr. Sperry died twenty-five years ago.

R. J. S. Pigott, *left,* past-president ASME, receives the Diamond Jubilee Medal from D. W. R. Morgan, *right,* ASME President, as D. W. VerPlanck, *center,* Pittsburgh Section chairman, offers congratulations during the Mechanical-Engineering Conference on Supercritical Pressure Steam-Power Plants in Pittsburgh, Pa., April 4.

President Morgan, *left,* congratulates student members, *left to right,* R. Thomas Bundorf, University of Pittsburgh; Roger Dale Teeter, University of West Virginia; and John Edward Meyer, graduate student, Carnegie Institute of Technology, after presenting them with Diamond Jubilee Medals in recognition of their outstanding ASME work.

Pittsburgh Section Marks Society's Diamond Jubilee With Supercritical Pressure Steam-Power-Plants Conference

THE Pittsburgh Section of The American Society of Mechanical Engineers held a Mechanical-Engineering Conference on "Supercritical Pressure Steam-Power Plants" on April 4, 1955, at the Hotel William Penn, Pittsburgh, Pa., to celebrate the Society's Diamond Jubilee.

Diamond Jubilee Mechanical-Engineering Conference

In the continuing effort to hold down the cost of power, engineers have ever been seeking for ways to improve thermal efficiency. Attention was directed for many years toward the steady advance of throttle temperature. Now the focus is shifting to pressures far above the critical. Noting that comparatively little information was available on the problems presented by designing for higher and ever higher pressures, the Pittsburgh Section decided to present a symposium on the subject of supercritical pressure.

It was believed that such a program would be interesting to engineers in varying branches of work since the problems encountered embrace metallurgy, water treatment, structural and machine design at elevated temperatures, and controls. That their decision was a sound one was evidenced by an attendance at the all-day session of 284 members, guests, and students.

T. E. Purcell, past vice-president and Fellow ASME, consulting engineer, presided over the morning session with the assistance of C. B. Withers, manager of the Albright Power Station of the Monongahela Power Company. Papers presented at this session were: Thermodynamic Analysis of the Supercritical Steam-Power Plants, by Jerome Bartels of Polytechnic Institute of Brooklyn; Problems of the Supercritical Turbine Design, by C. B. Campbell of Westinghouse Electric Corporation South Philadelphia Works; and Boiler Feed Pumps for Supercritical Power Plants, by I. J. Karassik of Worthington Corporation.

Conference Luncheon

Following luncheon for 180 members and guests, at which a motion picture on the behavior of water and steam in a gage glass as they pass into the critical-pressure range was shown, an afternoon session was held. The guests were welcomed by D. W. VerPlanck, chairman, Pittsburgh Section, ASME.

Afternoon Session

Presiding as chairman was Eugene Gordon, Mem. ASME, vice-president of Potomac Edison Company. E. L. Tindall, Mem. ASME, chief engineer, U. S. Steel Corporation, was vice-chairman of the session. The papers presented included: Developments in Supercritical Pressure-Steam Generators, by P. M. Brister of The Babcock & Wilcox Company; Water Problems in Power Generation at Supercritical Pressures, by E. P. Partridge of Hall Laboratories; and The Outlook for Supercritical Plants, by T. E. Purcell of Pittsburgh.

Among those presenting prepared discussions on the papers given at the morning and afternoon sessions were: A. H. Hollander, professor emeritus, California Institute of Technology and consulting engineer for Byron Jackson Company; T. Y. Mullen, Mem. ASME, Sanderson & Porter, New York, N. Y.; W. N. Flanagan, Mem. ASME, consulting engineer, Power and Fuel, U. S. Steel Corporation; M. D. Baker, chief chemist, West Penn Power Company, Pittsburgh, Pa.; S. F. Whirl, chemical-operating engineer, Duquesne Light Company, Pittsburgh, Pa.; J. K. Biedler, vice-president, Dravo Corporation; and J. A. Mikels, superintendent of power production, Ohio Edison Company.

Diamond Jubilee Banquet

A banquet attended by 200 members and their guests culminated the day-long meeting.

T. E. Purcell, chairman of morning session, and C. B. Withers, vice-chairman, attentive to a question from the floor during the Pittsburgh Section, ASME Diamond Jubilee Mechanical-Engineering Conference

Following the banquet, David W. R. Morgan, ASME President, talked most fittingly on the subject of future power generation. Mr. Morgan said that world-energy needs will increase fivefold by the year 2000 and 25 to 50 times by the year 2050 at which period the world will use as much power annually as it consumed from 1 A.D. to 1860. Coal, oil, gas, water power, sun, wind, and the earth's heat will not be adequate to meet demands at dates 100 years hence and Mr. Morgan declared that the one new source that seems to give promise of meeting such needs is found in the nucleus of the atom. Mr. Morgan pointed out that the only practicable method of converting atomic energy to electrical energy at present, was by means of the steam turbine. He said the part played by the gas turbine is not yet clear, but it seems apparent that it will not challenge the steam turbine in large sizes. Whether it can team up with nuclear reactors is not yet determined.

Honors

R. J. S. Pigott, past-president, ASME, who was retired recently as consulting engineer for Gulf Research & Development Company, Pittsburgh, Pa., was presented with the ASME Diamond Jubilee Medal as the member of the Pittsburgh Section who has done most to promote the aims, welfare, and principles of the ASME. The presentation was made by Mr. Morgan, who also presented medals to three outstanding student members. They were: John E. Meyer, Carnegie Institute of Technology; R. Thomas Bundorf, University of Pittsburgh; and Roger Dale Teeter, the University of West Virginia.

Committees in Charge of Conference

The various committees in charge of the mechanical-engineering conference included the following personnel: J. R. Aikins, *general chairman;* Program, R. M. Buchanan, *chairman;* Eugene Gordon, *vice-chairman*; R. P. Dodds, C. A. Erway, F. C. Rusch, W. J. Titzel, and P. D. Osterle; Reception, E. S. Howarth, *chairman*, H. H. Hauth, *vice-chairman*, D. W. VerPlanck, J. T. Bunting, and M. J. Warneke; Registration, C. M. Tyler, Jr., *chairman*, Walton Forstall, *vice-chairman*, L. B. Abrams, and Robert Stoner; Publicity, H. R. Fulton, *chairman;* J. W. Dashiell, *vice-chairman*.

ASME Fairfield County Section and Bullard Company Join to Celebrate 75th Anniversaries

Large Audience Hears L. K. Sillcox Speak; Tributes, Medals, and Honors Presented

The Fairfield County Section of The American Society of Mechanical Engineers, with headquarters in Bridgeport, Conn., held a dinner meeting on Tuesday, March 29, 1955, in Building No. 527 of the Bullard Company. The meeting was a joint commemoration of the 75th Anniversary of the Society and of the Bullard Company.

The Bullard Company, in mutual commemoration and in recognition of the important part played by the Society in promoting engineering knowledge, offered its facilities for this meeting. After the dinner, the more than 190 guests and members who attended adjourned to the Exhibit Auditorium where they saw a film entitled, "Yankee Toolmaker," and heard a talk by F. U. Hayes, vice-president, the Bullard Company, who discussed the company's development program. An opportunity was afforded the visitors to inspect the new Bullard model "75" and type "L" Mult-Au-Matic machines in operation.

Building for Better

Drawing a parallel between the anniversary of the Society and the company, L. K. Sillcox, past-president of ASME, said, "The center of faith is an absolute certainty of good, but to realize it one must possess vision, courage, and fortitude. This statement qualifies the outlook, typifies the thought and planning which have governed all that the Bullard Company and your Society have been able to accomplish during their 75 years of priceless leadership.

"It is important to remember that machine production began in the United States not because there were so many mechanically skilled people but because there were so few. Machinery was an absolute necessity in America and the inventors concentrated mainly on the largest possible production and, above all, the greatest speed. After 1850 "mechanics" became engineers; from then on precision increased, work became more and more specialized, elaborate mathematical calculations were applied, working drawings and, later, blueprints were many and exact, separately covering every tiniest part of every machine.

Machine-Tool Story in America

"Perhaps the most fascinating thing about the machine-tool story in America," said Dr. Sillcox, "is the fact that those who began it seemed almost to have been members of a single community. The area in which they operated was relatively limited, common occupations—farm, smithy, primitive machine shop, simple foundry—and the great incentive was to build better, to speed up and multiply production so that the few could supply the needs of the many. Nearly all of the men in business knew each other; they worked their apprenticeships in Vermont, Massachusetts, Rhode Island, and Connecticut. When we study the genealogy of the tremendous toolmaking companies of today we can nearly always trace the pedigrees back to the shops in cold, snowbound, rugged communities in the New England river valleys.

ASME Founded—Bullard Company Founded, 1880

"The need for information, and the means for training men adequately for their challenging tasks in these earlier times was vividly realized by Profs. John E. Sweet and Robert E. Thurston in February, 1880, when they succeeded in founding your Society. Strange as it may seem, during the same year Edward Payson Bullard launched his great career in founding the Bullard Company. Both had humble beginnings but became great leaders.

"Such a heritage," he stated, "has been sufficient to inspire those who were privileged

Shown, *left to right*, are W. E. Hogan, recipient of the 75th Anniversary Medal; L. K. Sillcox, past-president, ASME; C. E. Davies, secretary, ASME; and Ernest Hartford, consultant, ASME, during the inspection trip following the Fairfield County Section, ASME—the Bullard Company 75th Anniversary Dinner Meeting, March 29.

L. K. Sillcox, *left*, past-president ASME, presents commemorative plaque to the Bullard Company from the Fairfield County Section, ASME. F. U. Hayes, vice-president, the Bullard Company, accepts.

to follow them, to measure up to their challenge and their trust. Consider where we in America stand today. We have been told, and we have told ourselves, that we have the responsibility to lead. We are asked to keep freedom and progress alive. It is not a simple task. Leadership today requires not so much a determination to smash the other fellow as an understanding of the lessons of human experience. It requires a profound knowledge of our needs. It requires ability to anticipate the effects of conduct and action. In short, it requires thought. But who is doing the thinking? Do we take time to think? This is where your Society stands ready, willing, and competent to serve in 'building for better.'"

"Edward C. Bullard, president of Bullard Company," he concluded, "and a member of our Society since 1929, is continuing the courageous and splendid leadership already accorded his company through three quarters of a century, and we are proud to honor him this evening as an outstanding leader of a splendid team doing a great work."

Tributes and Awards

C. O. Kishibay, chairman of the Section, presided over this portion of the dinner program. He in turn called on J. E. Ettorre, vice-chairman of the Section, to present Harry E. Harris with the Section Award; Willis F. Thompson, vice-president, Region I, ASME, called on J. P. Heumann to receive the Past-Chairman's Award; C. E. Davies, secretary, ASME, called on W. E. Hogan to receive the ASME 75th Anniversary Award; and Dr. Sillcox presented the Commemorative Award, in the form of a plaque, to the Bullard Company, which was received for the company by F. U. Hayes.

ASME Takes Part in American Power Conference

CONTINUING its role as a leading forum for the power industry, the American Power Conference in its seventeenth annual meeting held at the Sherman Hotel in Chicago, Ill., on March 30, 31, and April 1, achieved new heights in the quality of its programming and quantity of its attendance. Presented at the conference were topics ranging in technical interest from solar energy through network analyzers to water treatment and having social and economic considerations as varied as the potential supply of engineers for the utility industry and the ramifications of multipurpose projects using water for irrigation, navigation, and power. Nor were conventional steam plants and the growing area of atomic power neglected by this outstanding meeting sponsored by the Illinois Institute of Technology with the co-operation of leading engineering societies, including The American Society of Mechanical Engineers, and a large number of universities. R. A. Budenholzer and E. R. Whitehead of Illinois Institute of Technology acted, respectively, as director and secretary of the conference, ably assisted by a well-chosen industry committee under the chairmanship of D. A. Sullivan of the Commonwealth Edison Company of Chicago.

"Where We Stand Today in the Utility Industry" was the subject of the opening address by John W. Evers, president of the Commonwealth Edison Company. Pointing to evolutionary nature of engineering developments since the inception of the central station, Mr. Evers stated that the new horizons in atomic power demand the same brand of vision and courage shown by industry pioneers more than 50 years ago when the steam turbine was first being adopted. He added that there is reasonable certainty that nuclear power will some day compete economically with conventional plants, perhaps before 1965.

ASME Luncheon

At a luncheon sponsored by the ASME, Harold Quinton, president of Southern California Edison Company, emphasized that the electric-utility industry is essentially an engineering business, with its engineers being responsible for enormous expenditures of money as well as a dependable supply of vital service. He pointed out that engineering accomplishments which are often highly publicized in other industries are considered routine in the utilities, which are in some respects remiss in not making more generally known these technical achievements. Mr. Quinton added that there is a unique feature of the utility industry which is not widely known but which should be of great interest and considerable attractiveness to young engineers. This is the complete freedom of exchange of ideas, experience, developments, and progress which takes place between utility companies and their suppliers and through engineering societies and trade organizations. It is this free interchange and rapid communication that enables the utility industry to make rapid technical progress.

All Engineers Dinner

Speaking at the All Engineers Dinner, Alexander M. Beebee, president of Rochester Gas & Electric Company, raised the question, "Are Public Power Programs in the Public Interest"? He concluded that the principles underlying public power programs have outlived their usefulness, no longer serve the public interest and, therefore, should be revised. If our country is to grow and prosper, there must be equality of opportunity and equality of taxation, without having certain groups or certain areas avoiding their fair share of the tax burden and either enticing or competing with industries from other areas.

To correct present inequalities, Mr. Beebee urged the following three steps:

1 The present policy of "preference" in the sale of power from public developments is discriminatory and should be eliminated.

2 When private enterprise fails to develop sound multipurpose programs for the public good, we cannot criticize the government for doing so.

3 Although many public power programs have or are now considering financing their programs by tax-free bonds, the loss in taxes can be greater than the apparent reduction in interest charges, thereby benefiting a few at the expense of the many.

Luncheon Speakers

Clarence H. Linder, vice-president of General Electric Co., addressing a luncheon sponsored by the AIEE, predicted that the requirements for designing, building, and maintaining the specialized machines that will go into automatic factories will increase the demand for technical manpower. He stated that the fundamental force acting to put a premium on technically trained manpower is the tremendous rate at which technology is growing, both in volume and complexity. But engineering training must not be too narrowly technical, for the young engineer, in addition to broad training in mathematics and the physical sciences, must have some education in the humanities, the social sciences, and in the communication of ideas. Pointing out that a large number of intellectually qualified people fail to emerge as college graduates, Mr. Linder suggested that industry apply familiar techniques of motivating people in encouraging secondary schools to provide the incentive for pupils to go on to college.

At the concluding luncheon sponsored by the Western Society of Engineers, Farrington Daniels, chairman of the department of chemistry at the University of Wisconsin, stressed some of the impelling reasons for the parallel development of atomic and solar-energy resources. With the world united physically by instantaneous communication and rapid transportation, complacent isolation has disappeared and in its place has come intense competition for the good will of all nations. In addition to humanitarian desires there is an understandable selfish motive to help the nonindustrialized nations attain a higher standard

of living. Professor Daniels suggested that we must begin to think of atomic and solar energy competing with manpower in Asia, Africa, and South America. This thinking should be in terms of kilowatt hours per dollar of investment and per ton-mile of transportation rather than in terms of kilowatthours per pound of coal or per gallon of gasoline. While believing that both atomic energy and solar energy will move forward rapidly, Professor Daniels expressed the opinion that atomic energy will come in large, expensive units as central-power stations, while solar energy will come in small, inexpensive units in rural areas.

With regard to solar energy, the long-range hope lies in photochemistry and in photoelectricity. An endothermic reaction is needed in which products produced by sunlight can be stored and used later to supply the energy absorbed from the sunlight. In closing, Professor Daniels emphasized that there is no new era of solar energy just around the corner, but that even now it can compete with animal and manpower. We owe it to our friends in the nonindustrial countries and to our grandchildren, he concluded, to start now an extensive program of research and development on the utilization of solar energy.

Are You Legally an Engineer?

By Newell L. Freeman,[1] Mem. ASME

THIS article is an endeavor by the ASME Engineers Registration Committee to bring to the attention of the membership the increasing need for each who calls himself an engineer to obtain legal status as a professional engineer. Too many engineers are so dedicated to their work that they are oblivious to statutory restrictions which have grown up around them. Many do not realize that all engineering is vital to the welfare of the public and is subject to statutory regulation. Nevertheless, every state now has a registration law in engineering. Some "license" engineers but most "register" engineers for practice.

Statutory Registration

While engineering is a profession as old as civilization, the advent of statutory registration therefore is comparatively recent. Early in the twentieth century the public's attention was attracted to matters related to engineering by various tragic events resulting from faulty planning and design. Many of these disasters involved structures so that this was recognized in the first legislation on engineering.

Registration (or licensure) in the profession began in Wyoming in 1907 when it became necessary to regulate by law the practice of engineering in connection with that state's irrigation program. All other states, three territories, and the District of Columbia since have acquired statutes of a similar nature. The most recent was enacted in 1950 for the District of Columbia. These statutes are administered by boards with various titles such as "Board of Engineering Examiners." While such a board is an official State agency it is also a committee of the profession. With the rapid and steadily increasing development and expansion of engineering, most registration laws now include all branches of the profession.

Registration Protects Public

Registration of engineers is primarily for the protection of the public and the public must be the first consideration of the practitioner. The profession and the individuals in it must rank second. The public is interested in protecting itself from the incompetent and the unprincipled who seek to prey upon it in the name of engineering. It wants an available supply of dependable engineers. The public is not particularly concerned about providing a better way of life for engineers except as it serves the public's interests. However, it generally develops that what is good for the public is good for the profession and what is good for the profession is good for the public.

Requirements for Registration

Certain considerations characterize most of the registration laws. One of the most important is that only those who have satisfied the requirements prescribed by law may register as professional engineers. Another is that the profession has the responsibility of determining who is qualified to practice and who should be rejected as not qualified. The principle followed is that, for the protection of the public, the exclusive right to practice in the field of engineering has been reserved for those who satisfy the legally prescribed qualification requirements. While integrity is the keystone of a profession, the profession itself has the task of determining what the exact requirements are and when they have been satisfied. This recognizes an age-old custom whereby the qualifications of learned individuals are judged by others of similar learning who have already established their qualifications. Thus, beyond a general outline in the law of what the public requires, the profession is expected to administer itself and is given the right of self-preparation and self-determination. The board is the official committee of the profession; it determines what constitutes adequate education and experience and authorizes an applicant to practice only when he is found to have satisfied the qualification requirements. It is believed that the public will be served best in this manner.

Engineers' Responsibility

In addition, an obligation is incurred by those engaged in engineering. As good citizens, it is incumbent upon each to respond to the spirit as well as the letter of the law. Even now, many regard this duty with apathy and fail to realize that professional status carries with it a special form of citizenship and a preferred position in society and the courts. Herein is an opportunity for engineers to function as a group with common interests which are above and beyond the limited responsibilities of technicians and technical experts.

Each state has its own statutory qualification requirements. The application forms are designed around them and arranged to include whatever additional information the Board believes necessary for its consideration. The applicant is required to make affidavit concerning the truth of the statements contained in the completed form.

At this time about one half of those who consider themselves to be engineers have obtained registration. While there is a strong trend for the younger members of the profession to take the necessary legal steps, many of the older ones are reluctant to do so. The latter position is becoming untenable with the passing of time. Legislation is under way in one section of the country whereby, "The practice of professional engineering is recognized, in the public welfare, as the basic function and responsibility of an individual or individuals duly registered to practice professional engineering—(as provided by this Statute)." This is a prelude to an impending situation whereby all engineering practice either by employed or self-employed must be carried on only by those who have legal status as engineers. It follows that a lack of registration will prevent further advancement for many who otherwise could look forward to promising futures.

The membership is urged to look up from its other preoccupations and do something about this important personal matter.

[1] Secretary, New York State Board of Examiners of Professional Engineers and Land Surveyors, Albany, N. Y.

AIChE-ASME Joint Symposium on Heat Transfer Held in Louisville

ON March 21, 22, and 23 the Heat Transfer Division of The American Society of Mechanical Engineers joined the American Institute of Chemical Engineers in three sessions of a symposium on heat transfer. This is the second time the two engineering societies have joined in presenting papers on heat transfer. A total of 18 papers was presented in the three-day session, which were delivered before large audiences in the Flag Room of the Kentucky Hotel, Louisville, Ky.

Technical Papers

Work of researchers dealing with the mysteries of the basic mechanism of liquid boiling were presented. These engineers have expanded their work to use modern tools of radioactive tracing, solutions other than water, and tests of large equipment rather than small laboratory equipment.

With the coming use of atomic energy as a source of power, problems have come to light concerning the transfer of heat from the nuclear reactor to the equipment using the en-

ergy. Nuclear power depends on heat from atomic fission. The heat, generated in the center of insidiously radioactive atomic "piles," it was found, must be removed with less need of maintenance than was formerly considered necessary.

Inspection Trips

Ten industrial plants were included in the list for inspection. The plants visited were: E. I. du Pont de Nemours & Company, Inc.; Colgate-Palmolive Company; Joseph E. Seagram & Sons, Inc.; Tube Turns; Reynolds Metals Company; Henry Vogt Machine Company; Kentucky Synthetic Rubber Company; General Electric Company; Devoe & Reynolds Company; and Olin Mathieson Chemical Corporation.

Social Events

The local committee arranged an interesting social program for the entertainment of the members and their guests. On Tuesday evening, March 22, there was a reception and a banquet. Mark F. Ethridge, publisher, *The* (Louisville) *Courier-Journal* and *The Louisville Times*, delivered the principal banquet address. His topic dealt with the economic developments in Europe, with particular emphasis on West Germany and the progress in the chemical industry there. Barnett F. Dodge, president, AIChE, was present at the banquet and cordially greeted the guests.

ECPD Publishes Papers on Orientation and Training in Industry

A Group of four papers discussing orientation and training in modern industry are now available in a publication of the proceedings of the 22nd Annual Meeting of the Engineers' Council for Professional Development, held recently in Cincinnati, Ohio.

The papers were presented by representatives of four industrial firms which have been participating in the pilot study of the ECPD program known as "The First Five Years of Professional Development."

A summary of high lights given in these papers includes the following suggestions:

1 The essential need of industry is a loyal, efficient, and aggressive working organization.

2 Training is basically a way of operating with new people in the total-work situation.

3 Habits start being formed the first day on a job whether or not you want to train a man.

4 Making the trainee a part of a working team is an essential part of any realistic training program.

5 To work, not merely to observe, should be the key to each training assignment.

6 Put responsibility into trainee jobs. Make the trainee carry a burden and learn to produce.

7 A challenge to the individual is essential in the first job. It will bring out the best in any man and will effectively reduce turnover by holding the really good men.

8 Select the best boss for the trainee. This is particularly important on the first few assignments.

9 Flexibility in training assignments is necessary to serve the best interests and abilities of the individual and the company. Regimentation in training is to be avoided.

10 Follow-up on training must go on for a period of several years. Carry-over should be checked and provided for.

Discussers of training-program fundamentals included: Earl G. Huck, Cincinnati Gas & Electric Company; Charles B. Hedrick, Procter & Gamble Company; D. F. Pratt, Cincinnati Milling Machine Company; Joseph S. Alford, General Electric Company; and J. C. McKeon, Westinghouse Electric Corporation. All of these men were members of Cincinnati Industry Committee co-operating with ECPD in the study of the "First Five Years" program.

The publication also includes an introduction to the question of professional industrial training by A. C. Monteith, Hon. Mem. ASME, vice-president in charge of engineering, Westinghouse Electric Corporation, and president of the American Institute of Electrical Engineers; and a statement by Ernest S. Fields, vice-president and general manager of the Cincinnati Gas & Electric Company.

In addition, the publication includes a copy of the brochure describing the program for young graduate engineers during the "First Five Years" and a copy of the brochure reporting on "The Community Project in Professional Development" which has been studied recently in Cincinnati. Copies of the publication are available by addressing ECPD Committee on Professional Training, 322 Baldwin Hall, Cincinnati 21, Ohio.

R. W. Cox Reports on North Texas Section Activities

ASME members in Dallas, Texas, have organized a Petroleum Division of North Texas Section Luncheon Group, reports R. W. Cox, chairman, North Texas Section. The men meet once a month in a centrally located hotel for luncheon and fellowship with ASME associates in various petroleum industries. A speaker is provided and a program of interest to those engaged in this work are always arranged.

The response and enthusiasm for this organization has been amazing, according to Mr. Cox. He adds further, "We had no idea this conception for an ASME meeting, which was new to us, fulfilled such a need as is evident from an exceptionally good attendance average of approximately 80."

The first meeting of this group was last December 9 and each monthly meeting since then has become increasingly popular. Petroleum engineers in the Dallas area are inquiring about ASME membership. The efforts of individuals, such as John Stevenson and Mathew Freeman, and the limited costs to the Section in organizing this group will be more than compensated, Mr. Cox feels, by ASME member participation and growth in numbers. Continuing with this program, arrangements have been made for leaders in the petroleum industry to address future luncheons.

Meetings of Other Societies . . .

May 11–13
Engineering Institute of Canada, annual meeting, Royal York Hotel, Toronto, Ont., Can.

May 14–22
ACHEMA XI—chemical-plant and apparatus exhibition in conjunction with Congress of European Federation for Chemical Engineering, Frankfurt (Main), Germany

May 19–20
The Society of Naval Architects and Marine Engineers, spring meeting, Bellevue-Stratford Hotel, Philadelphia, Pa.

May 22–26
Air Pollution Control Association, 48th annual meeting, Sheraton-Cadillac Hotel, Detroit, Mich.

May 23–25
American Society for Quality Control, annual convention, Hotel Statler, New York, N. Y.

May 23–25
American Management Association, general management conference, Hotel Roosevelt, New York, N. Y.

May 23–28
International Internal-Combustion Engine Congress, The Hague, The Netherlands

May 25–26
American Iron & Steel Institute, general meeting, Waldorf-Astoria Hotel, New York, N. Y.

May 25–27
International Union of Theoretical and Applied Mechanics, Symposium on Fatigue, Stockholm, Sweden

May 30–June 10
Canadian International Trade Fair, Toronto, Ont., Can.

May 31–June 1
National Rivers and Harbors Congress, convention, Mayflower Hotel, Washington, D. C.

May 31–June 4
International Commission on Large Dams of World Power Conference, fifth congress, Paris, France

June 2–4
National Society of Professional Engineers, annual meeting, Bellevue-Stratford Hotel, Philadelphia, Pa.

June 4–15
Fourth World Petroleum Congress, Rome, Italy

June 6–10
American Petroleum Institute, Division of Production, midyear conference of Standardization Committees, Brown Palace, Denver, Colo.

June 6–18
International Organization for Standardization, General Assembly and Council, Stockholm, Sweden

June 7–10
American Welding Society, spring meeting, Hotel Muehlebach, Kansas City, Mo.

June 12–15
American Society of Agricultural Engineers, annual meeting, University of Illinois, Urbana, Ill.

June 12–15
American Society of Refrigerating Engineers, semi-annual meeting, Hotel Schroeder, Milwaukee, Wis.

June 12–17
Society of Automotive Engineers, summer meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 13–16
Edison Electric Institute, annual convention, Philharmonic Auditorium, Los Angeles, Calif.

June 13–17
National Association of Power Engineers, national convention, Waldorf-Astoria Hotel, New York, N. Y.

(ASME Calendar of Coming Events, see page 464)

Junior Forum . . .

Conducted by R. A. Cederberg,[1] Assoc. Mem. ASME

Report from Philadelphia

By George J. Kolsun,[2] Assoc. Mem. ASME

"The BS degree is a ticket to a highly competitive race." Thus spoke D. W. R. Morgan, the National President of ASME, at a recent dinner sponsored by the Associate Group of the Philadelphia Section. At this meeting a group of "sponsorers" who are responsible, successful engineers were dinner hosts to engineering students from the University of Pennsylvania, Swarthmore, Villanova, and Drexel Institute of Technology.

After a brief welcome by the Associate Group Chairman, Norman Deming, and some spirited singing led by V. Sanderson and G. Spahr, the chairman of the Senior Section, James Quaid, introduced Dr. Morgan. The 75th Anniversary Medal for outstanding service in furthering the aims and objectives of the Society was then presented to Justin J. McCarthy by the President. Honorary memberships were presented to three 35-year members, James P. Harbeson, Ernest Hopping, and Karl Howard. A certificate of award was presented to past Associate Chairman, C. Clarence Franck.

Dr. Morgan's address was entitled, "Where Do You Go From Here?" It was aimed directly at the graduating engineer and the associate members of the Society. The President, in elaborating on the 75th Anniversary motto, "By Truth and By Service to Enrich Mankind," explained what qualities the employer has a right to expect of his employees—namely, loyalty, honesty, application, dispatch, accuracy, punctuality, teamwork, and co-operation. He said he believed that one of the big problems facing the recent college graduate is that of finding his place professionally. He felt that for an engineer to find his place in his profession he must take an active part in Society affairs, work toward professional registration, and capably perform the duties of his present job. At the same time he must determine the requirements for the next step ahead as well as the highest level upon which his sights have been set. Dr. Morgan also stressed the importance of taking an active part in community and civic affairs in order to develop a well-rounded background.

Dr. Morgan mentioned the important role played by past-presidents and officers from the Philadelphia Section. He also expressed a deep sense of gratitude for the advice and guidance that the Society provided him as a fledgling engineer.

Following Dr. Morgan's inspiring address, the meeting was closed, thus concluding another successful evening full of ASME fellowship and guidance.

[1] Westinghouse Electric Corp., Radio-Television Division, Metuchen, N. J.

[2] George J. Kolsun, Sun Oil Co., Philadelphia, Pa.

Transfer Information for Veterans and Future Veterans

By Richard A. Cederberg[1]

Veterans—Here is some information that will be of particular interest to you if you have, or will have, completed your college program in your late twenties or early thirties as a result of having had your college program interrupted by military service. The information concerns an apparent discrepancy in Society policy covering the transfer from associate member to member. As you probably know, the amount of dues paid by associate members is determined by their age and the number of years from graduation. The dues are $10 per year for seven years after graduation or until the age of 30 is reached, whichever occurs later. The dues are $20 per year between the age of 30 and 33 or from seven to ten years following graduation, whichever occurs later. After reaching age 33 or after ten years following graduation, whichever occurs later, the dues are $25 per year.

So far so good. But the promotion fee of $10 required when moving from associate member to member is not required if an applicant for transfer has been an associate member for five years and is under 33 years of age. It can readily be seen that if a tour of active duty interrupted your college program for a long period you will be over 33 by the time you have completed the necessary five years as an associate member. A check with Headquarters reveals that these cases are handled on an individual basis. Consequently, if you are faced with the problem of paying the $10 promotion fee because a tour of active duty delayed your date of graduation, contact Headquarters in writing, explaining your situation and they will waive the transfer fee.

Future Veterans—Many mechanical-engineering graduates have been graduating and entering the service without giving adequate consideration to their ASME membership. If you are currently a student member of ASME eligible to transfer to associate member upon graduation and plan to enlist or will be inducted into the Armed Services, you may have your transfer held in abeyance during the period that you are in the service. To do so you must advise ASME Headquarters in writing of the date that you begin active duty. An alternate course of action is to have your Honorary Chairman send headquarters the date that you enter active duty.

Your date of transfer from student member to associate member will be the date that you pay your first year's dues upon return from the service. To avoid payment of the $10 initiation fee you must apply for transfer within nine months after release from active duty. Applications received after this time will be treated as applications for admission and the $10 initiation fee will have to be paid.

. . . Chairman's Corner[3]

Additional benefits of ASME membership—The importance of getting out and meeting your fellow engineers in local activities, at national meetings, and at informal affairs should not be underrated or overlooked. The Society is your professional town meeting, your professional congress. It is your professional community. It is there that you meet your fellow engineers, hear of current developments, and discuss current problems with top men of the engineering world, be they scientists or executives. It is this association that enables you to evaluate yourself in relation to other young engineers and your progress with theirs. Here you can also see how your goals compare with the achievements of some of the older members whom you will meet. Don't underrate this opportunity that you have.

Looking for a new job—If you are shopping around for a new job it will be well worth your time to investigate such things as employee relations, financial stability, unionization of professional employees, opportunity for advancement, and the amount of encouragement given those persons interested in participating in professional activities. If the company treats their engineers as professional men you will most likely be happier in your position. One of the best sources of financial information is the company's annual report, so look it over rather carefully. Another good source of information is present employees of the company. A brief conversation with current employees can frequently give a better picture of the company than all the printed information ever written. Once you accept a position with a new company, continue to check on the company's stability and growth prospects. If the company prospers, your chances of prospering will, of course, be greater. It all boils down to a question of knowing your company before and after you take a job.

Herbert Hoover's Boyhood Home Restored

The boyhood home of Herbert Hoover in the small Quaker town of Newberg, Ore., has been purchased and is now in the process of being restored and refurnished. A group of former fellow townsmen and friends are organized as the Herbert Hoover Foundation and headed up by Burt Brown Barker, vice-president of the University of Oregon. Newberg, where the house stands, has named its park for him and the Oregon Highway Commission has named

[3] Chairman of National Junior Committee, Charles T. Miller, Engineering Division, Wright Aeronautical Division, Curtiss-Wright Corp., Wood-Ridge, N. J.

the highway from Portland to Newberg, the Herbert Hoover Highway. Mr. Hoover has been invited by the Oregon Legislature to attend the opening of this house on his eighty-first birthday, Aug. 10, 1955.

Born in West Branch, Iowa, Herbert Hoover lost his father at the age of six, his mother when he was only eight, and lived until he was ten years old with his uncles, one in Indian Territory, now Oklahoma, and another near West Branch. A brother of his mother, H. J. Minthorn, living in Newberg, arranged for young Hoover to come and live with him. Here he attended the newly organized Friends Academy of Newberg, of which Dr. Minthorn was the principal.

As it was at Newberg that Herbert Hoover spent his youthful days up to the time of going to Stanford, it is the purpose of the Foundation to restore the house and its furnishings to the original condition so far as that may be possible and they have been fortunate in being able to accomplish this to a considerable degree with much of the furniture that was actually in the house during those years, including photographs, portraits, and documents dating back to that time.

The Foundation's work has been carried out under the handicap of greatly limited funds as it has been supported entirely by voluntary contributions. No general campaign has been made. Outside of the immediate neighborhood and the circle of friends who have interested themselves in the movement, comparatively few people know about it.

To those who respect and admire this great American, for whom tardy recognition is only now beginning to be shown, for the long and devoted service given to his country, this project offers an opportunity to express individual appreciation. Any contributions for the restoration and maintenance of Herbert Hoover's boyhood home will be welcomed by the Foundation and put to good use. Checks should be made out to the Herbert Hoover Foundation and addressed to Dr. Burt Brown Barker, 3438 S.W. Brentwood Drive, Portland, Ore.

Actions of the ASME Executive Committee

At a Meeting at Headquarters on March 22, 1955

A MEETING of the Executive Committee of the Council was held on March 22, 1955, in the rooms of the Society. David W. R. Morgan, chairman, presided. In addition to Mr. Morgan there were present: F. L. Bradley, Thompson Chandler; A. C. Pasini and W. F. Thompson, of the Executive Committee; E. J. Kates, assistant treasurer; W. H. Byrne, vice-president; R. B. Lea and Joseph Pope, directors; C. E. Davies, secretary; O. B. Schier, 2nd, and T. A. Marshall, assistant secretaries; and Ernest Hartford, consultant.

Fees for Meeting Rooms

At a recent meeting the Board on Technology considered a policy covering hotel charges for meeting rooms which was drafted by the Committee of Secretaries of Engineers Joint Council. Upon recommendation of the Board on Technology, the Executive Committee approved the following policy on fees for meeting rooms:

"It is the policy of the organization endorsing this statement to conduct conventions, meetings, and conferences in hotels where no charges are imposed for the rooms used for committee meetings, technical sessions, general business meetings, and conferences of members or delegates. Where hotel facilities are not available without charge for such use, such meetings, conventions, or conferences shall be held in other meeting rooms where charges are not imposed."

This policy is not a new one, as the Council approved such a procedure in 1947. The policy was approved in this language to make it parallel that adopted by other EJC societies.

New Honorary Members

The Secretary reported that the following were elected Honorary Members of the ASME: Jakob Ackeret, Zurich, Switzerland; Detlev W. Bronk, New York, N. Y.; Ernest F. Mercier, Paris, France; and Hilding V. Tornebohm, Gothenburg, Sweden.

Student Branch at University of Puerto Rico

The Committee voted to continue the Student Branch at the University of Puerto Rico for another scholastic year ending June, 1956.

Travel Expense

The Executive Committee recently referred to the vice-presidents for recommendation the request from the Membership Development Committee that travel expenses be allotted to the eight Regional Membership Development Committee chairmen to meet with the vice-presidents during the November, 1955, Annual Meeting to be held in Chicago, Ill. On recommendation of the vice-presidents, the Executive Committee voted that expenses of the eight Regional Membership Development Committee chairmen not be paid pending further development of the Proposed Accelerated Program.

Membership Applications

It was voted to relieve the Sections and vice-presidents of the responsibility of approving applications for admission and applications for transfer from Student Member to Associate Member.

75th Anniversary Awards

On recommendation of the ASME representatives on ECPD, it was voted to award a special 75th Anniversary Medal and Certificate to L. F. Grant, president of ECPD for the past three years. The Award is in appreciation of his qualities of leadership which have made a great contribution to the work of ECPD, and as a tribute to him as a great leader, a great engineer, and a warm friend of ASME.

A special 75th Anniversary Medal and a Certificate were also voted for H. S. Osborne in recognition of his splendid leadership as president of the International Electrotechnical Commission.

Air-Pollution Symposium

The Reinhold Book Division of New York, N. Y., has submitted an agreement for the publication of a book containing the papers given at the Air-Pollution Symposium, March 1–2, 1955. Editorial and production work on the book is scheduled to be started shortly after agreement has been approved. The Executive Committee voted to authorize publication of the book.

Reinstatement of Student Branch

In 1951 the Council voted to withdraw the Student Branch from Ohio Northern University inasmuch as none of the engineering curricula at the university was accredited. The curriculum in mechanical engineering has now been accredited and it was voted to reinstate the Student Branch at the University.

1954 Power Show

The Secretary reported that a check was received from the International Exposition Company for final payment in connection with the 1954 Power Show. The sum is to be credited to the Research Reserve.

75-Year Membership

A special certificate was authorized for Henry Marx to commemorate his 75 years of membership in the Society. (See page 464.)

Certificates of Award

Robert Nelsen, retiring chairman of the National Junior Committee, was granted a certificate of award.

Harry Knecht, retiring chairman of the Metropolitan Section, was granted a certificate of award.

A certificate was granted to R. P. Lockett, Jr., who served as chairman of the New Orleans Section, 1952–1953.

Certificates of award were authorized for the following members of the Metropolitan Section for outstanding achievements: F. L. Bradley, Crosby Field, A. R. Mumford, and V. Weaver Smith.

A certificate was authorized for D. W. VerPlanck, who served as chairman of the Student Branch Committee, Region V, 1953–1954.

New Engineering Societies Building

The Secretary reported that the four other societies concerned with the new engineering societies building (ASCE, AIEE, AIME, and AIChE) did not favor a meeting of representa-

tives of the executive committees of the five societies to develop a method of solving the problem, as voted by the ASME Executive Committee recently.

The four other societies did favor retaining the Committee of Five Presidents. The Executive Committee voted:

1 That the Committee of Five Presidents remain active;

2 That they render a complete report stating the facts that were taken into consideration in coming to the conclusion that Pittsburgh, Pa., offered the best site for the new Engineering Societies Building, and that this report include as much of the pros and cons as possible;

3 That any information pertinent to the issue be sent to the Committee of Five Presidents for their use in preparing such report.

It was also suggested that L. K. Sillcox representing the ASME, urge that the Committee of Five Presidents have an early meeting with the United Engineering Trustees, Inc., to make certain that there will be understanding and co-operation between the two groups.

The Executive Committee reiterated its view that a full-time co-ordinator was necessary to work on this problem. The Secretary was requested to inform the United Engineering Trustees, the Committee of Five Presidents, and the other societies concerned of this action.

Elmer A. Sperry Award

Rules of award for the Elmer A. Sperry Award were approved. This award is to be administered by ASME. (See page 469.)

Appointments

The following appointments on committees and joint activities were approved:

Committee on Air-Pollution Controls: W. H. Claussen

Society Lectureship Committee: James H. Potter

Publications Committee: C. B. Peck to replace Colin Carmichael for one-year term—to December, 1955; Otto de Lorenzi to replace Colin Carmichael for the second year of his unexpired term—to December, 1956; John de S. Coutinho to replace Lee S. Whitson—five-year term.

Nuclear Engineering Division: A. C. Pasini, chairman, 1955; Alex D. Bailey, 1955; Thorvald A. Solberg, 1956; Bruce R. Prentice, 1957; William E. Shoupp, 1958; J. R. Menke to take office November, 1955, for a four-year term expiring in 1959; and R. C. Dalzell to take office November, 1955, for a five-year term expiring in 1960.

Boiler and Pressure Vessel Committee: Subcommittee on Special Design, L. P. Zick; Subcommittee on Unfired Pressure Vessels, J. F. Sebald.

ASA Sectional Committees: Safety Code for Elevators, A-17, Carl F. Hoffbauer; Standardization and Unification of Screw Threads, B-1, Edward McHugh; Wire Rope for Mines, M-11, Charles M. Haas; Standards for Drawings and Drafting Practice, Y-14, W. A. Siler.

United Engineering Trustees, Inc.: H. E. Martin, reappointment—four-year term.

Daniel Guggenheim Medal Board of Award: Floyd T. Hague, three-year term.

Hoover Medal Board of Award: Walker L. Cisler, six-year term.

Presidential Appointment

The following presidential appointments were noted: R. E. Derby and J. A. Quaid to American Academy of Political and Social Science, annual meeting, Philadelphia, Pa., April 1–2, 1955.

ASME Nuclear Engineering Division Announces Its Committee Organization

At a meeting held in New York on March 29, 1955, under the chairmanship of A. C. Pasini, the committee structure of the Nuclear Engineering Division was organized. The new Division was authorized by the Council on Nov. 29, 1954, on recommendation of the Professional Divisions Committee and the Board on Technology.

Members of the Executive Committee of the Nuclear Engineering Division and the years in which their terms of office expire are: A. C. Pasini, chairman (1955); A. D. Bailey (1955); T. A. Solberg (1956); B. R. Prentice (1957); and W. E. Shoupp (1958). It was announced that J. R. Menke would be appointed at the end of the year for a four-year term ending in 1959 and R. C. Dalzell at the end of 1955 for a five-year term ending in 1960.

R. C. Dalzell was elected secretary of the Division for 1955.

Advisers to the Division and its Executive Committee were appointed as follows: R. C. Allen, Allis-Chalmers Manufacturing Company; Walker L. Cisler, The Detroit Edison Company; J. R. Dunning, Columbia University; Martin Frisch, Foster Wheeler Corporation; J. J. Grebe, Dow Chemical Company; J. N. Landis, Bechtel Corporation; G. I. Ross, Ross and Company; Stanley Stokes, Union Electric Company of Missouri; and L. S. Wilcoxson, The Babcock & Wilcox Company.

Committee appointments were approved as follows:

Meetings and Program Committee: B. R. Prentice, chairman, R. G. Folsom, Martin Frisch, R. A. Tidball, J. A. Quaid, R. A. North, and D. M. Schoenfeld.

Papers Review Committee: W. E. Shoupp, chairman, W. E. Belcher, Jr., C. R. Braun, W. L. Fleischmann, K. A. Kesselring, L. L. Koch, B. F. Langer, W. J. McCarthy, Jr., and W. T. Moore.

By-Laws Committee: A. D. Bailey, chairman, J. N. Landis, vice-chairman, H. N. Blackmon, L. R. Gaty, H. B. Nottage, G. I. Ross, R. H. Shannon, and R. H. Tingey.

Annual Report Committee: T. A. Solberg, chairman, G. I. Ross, and J. N. Landis.

Honors and Awards Committee: Walker L. Cisler, chairman, K. M. Irwin, and Stanley Stokes.

Division Development Committee: J. R. Menke, chairman, R. C. Dalzell, M. Frisch, J. N. Landis, R. A. North, R. C. Ulmer, L. S. Wilcoxson.

EJC Congress Committees: J. R. Dunning, representative on General Committee; R. K. Hartwell, Program Committee, with H. A. Wagner and W. J. McCarthy, alternates; S. A. Tucker, Publications Committee.

R. B. Engdahl was appointed liaison representative to the ASME Research Committee.

J. L. Everett, 3rd, and A. R. Gruber, were appointed Junior Advisors and each committee was authorized to appoint one Junior Adviser.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members, or nonmembers and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph St.	100 Farnsworth Ave.	57 Post St.

Men Available[1]

Mechanical Engineer, 28; two years' experience co-ordinating expansion of turbine-laboratory facilities, specification and report writing; three years' experience as supervisor drop forge; one and one-half years' experience in manufacture power-plant equipment. Desires domestic or foreign employment. Me-207.

Mechanical Engineer, presently on AEC project directing installation of special electromechanical equipment, all phases. Desires similar

[1] All men listed hold some form of ASME membership.

position, or diversified development project. Me-208.

Mechanical Engineer, 27; married; three and one-half years' varied experience in synthetic textile manufacture including machine design, applied research and development, customer liaison, project co-ordination and supervision, report writing. Desires responsible position with small or medium-sized progressive manufacturer in northeastern U. S. Me-209.

Teaching Position, finishing PhD in applied mechanics. Graduate degrees in aeronautical engineering and physics; four years' research experience on various subjects. Me-210-151-Chicago.

Mechanical-Industrial Engineer, 33; background in chemistry, packaging, machine design, and manufacturing; experienced in cost controls, statistics, materials handling, methods, equipment design, technical writing, process development, sales. BSME and BA chemistry; veteran. Will relocate. Me-211.

Assistant or Chief Engineer, Development or Research; MSME; development, design, research in mechanical products and associated equipment, particularly rotating machinery and facilities; 20 years' experience, seven at executive level. Me-212.

Head of Research and Engineering Departments, small manufacturer of heat-transfer equipment for heating, refrigeration, and aircraft industries. Desires a position with good future. MS; PhD in mechanical engineering; 11 years' industrial and academic experience. Me-213.

Mechanical Engineer, 30; married; BME; PE; seven years' variety and baked-foods manufacture; processing, packaging, materials handling, plant-equipment design, and maintenance. Machine-shop and tool-design experience. Will travel or relocate. Me-214.

General Manager-Treasurer, 25 years' experience general manager, treasurer, production-control supervisor, purchasing agent. Directed cost-control, cost-reduction programs. Experienced with labor-union negotiations. Desires executive position. Me-215.

Engineer, BSME; eight years' experience abroad in operational, sales, and administrative phases of petroleum marketing. Speaks and writes fluent Portuguese and some Spanish. Desires permanent sales or administrative position in South or Central America. Me-216.

Project Engineer, 34; married; BSME; registered PE; four years' experience in design and cost estimating of construction and steel fabrication; three years as project engineer in atomic-energy research and development. Desires responsible position with possibilities toward a company-representative position in the Orient. Me-217-175-Chicago.

General Manager, Chief Engineer, or Research Director; 35; experienced in metals fabrication, production machining, government contracts, labor relations, management functions. Me-218.

Chief Manufacturing Engineer, experienced in mass production of small-metal parts and assemblies; good organizer; cost-conscious; experienced in tool design, automation, processing, cost estimating, design for economical production. Me-219.

Sales Engineer, 29; BSME; three years' experience sales and application pumps, compressors, blowers, steam condensers, diesel, and gas engines; four and a half years' Navy and Merchant Marine experience in power-plant equipment. Me-220-176-Chicago.

Mechanical Engineer, BSME; 36; married; 13 years' experience in plant engineering, design, construction, and maintenance of paper and chemical-processing equipment, production, and plant facilities. Desires northern N. J. location. Me-221.

Positions Available

Plant Engineer, 33–35, mechanical, about ten years' experience in a chemical plant; some design experience. Experience or knowledge of electrical distribution, boiler operation, and steam distribution, building knowledge, report writing, estimating, and maintenance systems. $10,000–$15,000. New England. W-915.

Chief Engineer, product department, mechanical or electrical graduate, to direct all engineering activities covering design, manufacture, installation, and operation, and research activities in electrical and mechanical process-equipment fields. $10,000–$12,000. East coast. W-964.

Engineers. (*a*) Director of engineering, 40–50, graduate mechanical, at least 20 years' experience; ability and know-how in machine design, to be top executive reporting to president of company. Must have proved record of administrative ability. Salary open, plus bonus. (*b*) Project engineer, 35–50, graduate mechanical, at least 15 years' experience. Will work for a company primarily engaged in machine design such as steel-forming equipment, solder-type mills, forming mills, pipe mills, etc. Applicant must know general construction of machinery. Salary open, plus bonus. Ohio. W-1012

Director of Engineering and Design, considerable experience in small hand-electric tools. Knowledge of casting and series-wound motors. $12,000–$15,000. Midwest. W-1078.

Director of Engineering, 30–40, graduate, experienced handling mechanical-engineering problems of development and design in a competitive market; should have sound judgment in the practical application of devices; be promotional-minded. $12,000–$18,000. Midwest. W-1084.

Industrial-Engineering Consultant, about 30, graduate mechanical, at least six years' experience in industry, preferably hard-goods line. Should have experience in one or more of the following areas in hard-goods manufacturing: Manufacturing-engineering processing, industrial engineering, or production control. Must be willing to travel. Headquarters, New York, N. Y. W-1095.

Engineers. (*b*) Equipment-specifications engineer, BSME; experienced in design, manufacture, sale, or operation of tire-service equipment (repair and treading machinery). $4800–$6000. (*c*) Senior machine-design and plant-layout engineer, BSME, five to ten years' experience in design and installation of heavy-process machinery. $6300–$7740. (*d*) Senior product engineer, 28–40, BSME, experience in development work on fuel cells, both bladder and self-sealing type; background in the rubber industry or rubber-industry experience with machine-design and/or general engineering experience. $6300–$7740. Ohio. W-1125.

Metallurgical and/or Mechanical Engineers, interest in metallurgy, for research and development in the field of working and fabrication of metals which are of interest to the atomic-energy program. Must be U. S. citizen, with, or able to obtain, government clearance. Boston, Mass. W-1127.

Assistant to Chief Engineer, 30, graduate mechanical, background in the design of machine tools or similar heavy machinery. Duties would include possibly some design work, investigations, reports, liaison between engineering and production of other departments, etc. Salary open. N. J. W-1135.

Chief Draftsman, 30–40, mechanical graduate, a minimum of ten years' experience in engineering and/or manufacturing, five of which must have been in machine design and three years in a supervisory position, either engineering or manufacturing; a theoretical and working knowledge of machine design required. $8000–$10,000. Fla. W-1226.

Director of Engineering, about 50. Will be responsible for the operation and administration of engineering activities involving a total of several hundred engineers, for accessary manufacturer to aircraft, automotive, and machinery industry. Must be graduate mechanical or electrical engineer, with comprehensive administrative experience. Up to $30,000, depending on experience. Bonus after first year, pension, and annuity. Midwest. W-1247.

Mechanical Engineer, to 40, BSME or aeronautical graduate, at least three years' experience preferably in airborne equipment, for work in design and development of gas-turbine engines, afterburners, and controls. $6000–$9000. Calif. W-1253.

Engineers. (*a*) Sales engineer, 35–45, mechanical, at least ten years' sales experience on boiler and steam-power-plant accessories. $8000–$10,000. (*b*) Sales assistant, mechanical, experience covering specifications, quotations, and correspondence on steam-power-plant specialties $4420–$6500. New York, N. Y. W-1262.

Chief Engineer, electrical, chemical, or mechanical graduate, at least ten years' engineering experience, plus proved administrative ability, to head up engineering department of leading manufacturer of industrial-process equipment in metropolitan Boston area. $12,000–$15,000. Employer will pay fee. W-1270.

Engineers. (*a*) Project manager, 30–40, graduate mechanical, to supervise junior engineers in test and research projects. $8500–$9500. (*b*) Project engineer, 30–40, graduate chemical engineer or mechanical, to administer and follow through on special test projects involved in engineering division. $7000–$8000. N. J. W-1321.

Factory Manager, under 40, experience in wood-match manufacturing plant. Preferably single. Housing provided. $10,000–$12,000, plus bonus. British East Africa. F-1330.

Design Engineers, graduate mechanical or civil, with industrial experience related to machine design, hydraulic design, and heavy fabrication design, as well as theoretical design of structures. Must be draft-exempt, citizen of the United States, and acceptable for confidential-clearance status. Salary open, dependent upon experience. Southern N. J. W-1338.

Mechanical or Chemical Engineer, not over 40, for production management, experience as foreman, for a manufacturer of finished chemical specialties—auto polishes, truck fluids, hydraulic fluids, plastic coatings, etc. $7000–$10,000. N. J. W-1358.

Chief Engineer, 35–42, mechanical or electrical graduate, design, production, and administrative experience covering FHP motors, synchros, and controls. $12,000. New England. W-1374.

Designer, cranes and shovels, mechanical, 40–50, at least five years' experience in designing construction machinery; knowledge of complete unit and speeds. Duties include designing construction equipment and later supervising other engineers. Up to $12,000. Employer will negotiate fee. Ill. C-2760.

Project Engineer—Heating Controls, mechanical or electrical, 30–45, at least five years' experience in research and development in heating controls, oil, or gas; knowledge of AGA and Underwriters' requirements. Will develop and design heating controls for gas and oil burners. $7000–$8500. Employer will negotiate fee. Ill. C-2761.

Project Supervisor, mechanical, 35–45, at least four years' experience in shop practices in sheet metal and plate stamping, forming and welding, and preferably mufflers; knowledge of acoustical theory and practice. Duties include analyses of acoustical theory and practice for mufflers; direction of design and development, including production aspects; customer contact as a technical representative. $7200–$8500. Minn. C-2781.

Industrial Engineer, industrial or mechanical, 30–40, at least five years' experience in sheet-metal fabricating. Will set up program of industrial engineering and make it operate. $8000–$12,000. Employer will negotiate fee. Ohio. C-2786.

Plant Engineer, mechanical, 30–50, at least five years' experience in plant maintenance and installation of heavy equipment; knowledge of electrical, hydraulic, and inorganic chemical-processing equipment desirable. Duties include plant engineering, maintenance, building improvements, boilers, hydraulic and electrical equipment, bridge cranes, and chemical-processing equipment, in general, for a tin salvager. $8500. Employer will negotiate fee. Calumet district. C-2840.

Candidates for Membership and Transfer in the ASME

The application of each of the candidates listed below is to be voted on after May 25, 1955, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

Key to Abbreviation

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member

New Applications

For Member, Associate Member, or Affiliate

ACKERMAN, CHARLES M., Bay City, Mich.
ATKINSON, JOHN G., Halethorpe, Md.
AULL, ROGER J., Indianapolis, Ind.
BALLIN, THEODORE N., Chicago, Ill.
BANDA, MICHAEL, Turtle Creek, Pa.
BANG, BERNHARD A., Bethesda, Md.
BAVER, CLYDE B., Fanwood, N. J.

(*ASME News continued on page 480*)

new WIDER VISION for easier remote boiler water level readings

■ Vastly improved visibility of remote boiler water level readings can now be enjoyed by boiler plant operators.

A new "wide vision" face on Yarway Remote Liquid Level Indicators allows reading from the side as well as front of the indicator. Boiler water levels and other liquid levels can be checked from most any position.

Indicating mechanism is operated by the boiler water level itself—assuring instant, accurate readings.

Yarway Indicators are of the manometric type with automatic temperature compensation, as approved for use under the recent A.S.M.E. Boiler Code Committee ruling in Case #1155.

Over 10,000 are used throughout industry for boiler water and other liquid level indication . . . and for superheater pressure differential indication aboard ship.

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■ Yarway Hi-Lo-Graph Recorder provides not only water level indication, but also a 24-hour recording of water levels. See Yarway Bulletin WG-1830.

■ Yarway Remote Hi-Lo-Alarm Signals—lights or horns—can be placed at any location in plant. See Yarway Bulletin WG-1823.

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BECKER, EARL M., Pittsburgh, Pa.
BELL, FRED R., JR., Mobile, Ala.
BERILLA, THOMAS, Jeannette, Pa.
BIBBY, R. DOLMAN, Lynchburg, Va.
BOHM, ROBERT T., Glen Oaks, N. Y.
BOZ, CHARLES A., Toledo, Ohio
BREESE, JAMES L., 3RD, Santa Fe, N. Mex.
BURCH, WILLIAM A., JR., Greenville, S. C.
CAMPBELL, ROBERT J., Worcester, Mass.
CARLETTI, LEDO R., Wantagh, N. Y.
CARTER, EDWARD E., St. Paul, Minn.
CARTER, RAYMOND H., Keen, N. H.
CLAY, RICHARD H., Pittsburgh, Pa.
COOK, CHARLES W., Charleston, W. Va.
COONEY, RICHARD T., Gibraltar, Mich.
CORNWELL, HOWARD L., Royal Oak, Mich.
GRANDALL, WILLARD A., New York, N. Y.
CREVELING, JOHN H., JR., Berkeley, Calif.
CROSS, RICHARD V., Florissant, Mo.
DAY, WILLIAM C., Columbus, Ohio
DECHERRIE, THEODORE H., Chicago, Ill.
DERBY, RALPH E., Hartford, Conn.
DIEHL, CONRAD, Passaic, N. J.
DIXON, JOHN L., Charleston, W. Va.
DRAPPONE, AMERICO P., Mattapan, Mass.
DUNN, CHARLES M., Pensacola, Fla.
DU PONT, FRANCIS G., Bridgeport, Conn.
DYRKACZ, WASIL W., Newtonville, N. Y.
EBERHARD, WALTER O., North Bellmore, N. Y.
FAGAN, GEORGE J., Glen Burnie, Md.
FARR, DONALD E., Pittsburgh, Pa.
FAUS, ROBERT B., JR., Honolulu, T. H.
FOUNTAIN, RICHARD J., Fostoria, Ohio
FOWLE, ARTHUR A., Waltham, Mass.
FRENCH, WILLIAM D., Latrobe, Pa.
FREUDMAN, ERNEST, Chicago, Ill.
GHOSH, DEBA B., Derby, England
GOLDBERG, NORMAN, Brooklyn, N. Y.
GOMBERT, DIETER W., Chicago, Ill.
GRAVES, WILLIAM A., Fort Collins, Colo.
GUPTA, MUKUL, London, England
HALES, HARVEY E., Savannah, Ga.
HAMBERG, MARVIN, Philadelphia, Pa.
HANAY, JOSEPH J., New York, N. Y.
HANDY, JOHN W., Rochester, N. Y.
HARTEL, GALE E., Canal Fulton, Ohio
HASSAN, KAMAL E., Chicago, Ill.
HENDERSON, GEORGE B., Houston, Texas
HERTEL, WILLIAM A., South Euclid, Ohio
HILDENSTEIN, WENDELL C., Edwardsville, Ill.
HOCHMUTH, ERNEST, Chicago, Ill.
HOOD, L. JOHN, East Peoria, Ill.
HORN, WILLIAM E., Philadelphia, Pa.
HOTOPP, ALBERT C., Belle, W. Va.
JAKOBSEN, JAKOB K., Olean, N. Y.
JAROS, ZYGMUNT, Long Island City, N. Y.
JARVIS, HOYT A., Falcon, Venezuela
JOHNSON, JAMES A., Lakewood, R. I.
KAPPEL, VICTOR, Trumbull, Conn.
KARMAZIN, JAN E. L., Rancagua, Chile
KINSMAN, FRANK W., Murray Hill, N. J.
KIRKDOFFER, NOAH R., East Chicago, Ind.
KLEGAR, DAVID, Chicago, Ill.
KRAMER, ANDREW W., Lake Bluff, Ill.
KREH, EDWARD J., JR., Pittsburgh, Pa.
KURLEJ, JOHN S., Greensburg, Pa.
LANGLOIS, ARTHUR J., Racine, Wis.
LAUFFER, WILLIAM D., Philadelphia, Pa.
LETORUNEAU, BUDD W., Pittsburgh, Pa.
LEVY, SHELDON L., Kansas City, Mo.
LOCKLIN, LEON B., Atlanta, Ga.
MACDONALD, ALEXANDER G., Montreal, P. Q., Can.
MADDUX, FRED W., JR., Spokane, Wash.
MCNEW, ROBERT H., JR., Augusta, Ga.
MILLER, WALTER S., Winchester, Mass.
MORFORD, JOSEPH V., JR., Freeland, Mich.
MOSS, GEORGE K., Orangeburg, S. C.
NAIDU, GOPALSAMI D., Coimbatore, India
NANNEN, WILLARD O., San Diego, Calif.
NEISWENDER, CHESTER P., JR., Pensacola, Fla.
NETZLEY, RICHARD D., Laura, Ohio
NICHOLSON, CARLTON K., Aiken, S. C.
NORTHRUP, GEORGE R., Pittsburgh, Pa.
OLIVER, ROBERT C., JR., Hickman Mills, Mo.
OVER, ARTHUR M., Pittsburgh, Pa.
PARKER, WALTER B., Glastonbury, Conn.
PAUL, VERNON F., South Charleston, W. Va.
PEAKE, ROBERT W., Wilmington, Del.
PEARSON, KIRK O., Oak Ridge, Tenn.
PHELPS, SAMUEL C., Shreveport, La.
PHILLIPS, THORTON A., Phoenix, Ariz.
PITCHFORD, ALBERT L., Wichita, Kan.
POPHAM, AUDREY J., Chicago, Ill.
PRICE, JOHN C., Schenectady, N. Y.
PULLEN, JOE W., Charleston, W. Va.
RICE, MILTON J., JR., Schenectady, N. Y.
ROBERTSON, RICHARD B., Houston, Texas
ROBINSON, ARTHUR R., Urbana, Ill.
ROGOWSKI, AUGUSTUS R., Needham, Mass.
RUNDLETT, THURMAN L., Pittsburgh, Pa.
RUST, ALBERT D., Angleton, Texas
SCHACK, MARVIN H., Richland, Wash.
SCHUMANN, CHARLES T., Los Angeles, Calif.
SCHWARTZ, THOMAS W., Philadelphia, Pa.
SHIPLEY, HOWARD V., Highland Creek, Ont., Can.
SHUH, LEWIS M., Davenport, Iowa
SHULER, JOE H., South Charleston, W. Va.
SIDLER, ERNEST E., Trenton, N. J.
SINICA, JOHN, JR., Cincinnati, Ohio
SMITH, ELLSWORTH W., Aiken, S. C.
SMITH, HOMER, JR., East Chicago, Ind.
SMITH, JAMES C., Augusta, Ga.
SPEARMAN, GUY M., Pensacola, Fla.
STAATS, ROBERT W., West Barrington, R. I.
STANLEY, WILLIAM J., Chicago, Ill.
STEWART, CHARLES B., JR., Charleston, W. Va.
STRATTON, REUEL F., Pittsburgh, Pa.
THOMPSON, ALLAN G., Pittsburgh, Pa.
TRUMP, PETER W., Fanwood, N. J.
TUCKER, DONALD G., Milwaukee, Wis.
TURNER, RICHARD D., Spokane, Wash.
VERMILYA, FLOYD D., New York, N. Y.
VILLERS-ALLERAND, PHILIPPE, Bellows Falls, Vt.
VISNICH, JOE E., Brookhaven, Ga.
WAGONER, CHARLES C., Richmond, Va.
WARD, WILLIAM H., JR., Maracaibo, Venezuela
WEISS, JOHN, Mount Vernon, N. Y.
WEST, RICHARD W., Irwin, Pa.
WHIPPEN, WARREN G., York, Pa.
WILLIAMS, EARL E., Augusta, Kan.
WITTEN, WESLEY M., Bakersfield, Calif.
WORSWICK, RONALD J., Orlando, Fla.
YEH, HSUAN, Baltimore, Md.
YOUNG, HENRY B., JR., Houston, Texas
YOUNG, JAMES B., Charleston, W. Va.

Change in Grading

Transfers to Member or Affiliate

ABERCROMBIE, RALPH D., JR., Milford, Conn.
ANISMAN, GEORGE F., Los Angeles, Calif.
ASHMEAD, RICHARD R., South Pasadena, Calif.
BERNSTEIN, MURRAY, Queens Village, N. Y.
CARVEY, THOMAS B., JR., Palos Verdes Estates, Calif.
DAUDT, LOUIS R., Aiken, S. C.
DEMING, NORMAN R., Newtown Square, Pa.
DUGGINS, RAY B., Old Hickory, Tenn.
DUNN, JAMES R., Schenectady, N. Y.
FLANAGAN, JAMES H., Boston, Mass.
FLOYD, SAMUEL B., JR., Wexford, Pa.
GARRARD, RICHARD F., Scotia, N. Y.
GIDEZ, MELVIN D., Boston, Mass.
HAFER, ALVIA A., Schenectady, N. Y.
HOLMES, ROBERT W., Rochester, N. Y.
KITCHIN, DONALD W., JR., Kimberton, Pa.
KROHN, EDMOND A., Dragerton, Utah
LYLE, EDWARD A., Tulsa, Okla.
MENKUS, MILTON, Norfolk, Conn.
MORGAN, WILLIAM R., Cincinnati, Ohio
O'CALLAGHAN, JOHN, Birmingham, Ala.
RAINE, GEORGE, Toronto, Ont., Can.
SHIRES, JOHN R., St. Catharines, Ont., Can.
SOUTER, JOHN C., Andover, Mass.
TAYLOR, RUSSELL C., Pasadena, Calif.
THOMPSON, ALFRED C., North Abington, Mass.
WILL, DONALD S., Long Beach, Calif.
WORK, RAYMOND P., Salt Lake City, Utah
YOUNGDAHL, PAUL F., Detroit, Mich.

Transfers from Student Member to Associate Member 80

Obituaries . . .

William Lewis Acker (1883–1954), president, Acker Drilling Co., Inc., Scranton, Pa., died in May, 1954. Born, Scranton, Pa., Feb. 27, 1883. Education, ME, Cornell University, 1905. He held patents on core-drill cutterhead and rotary core drill. Mem. ASME, 1954.

Allan Philip Colburn (1904–1955), consulting chemical engineer, provost of the University of Delaware, died Feb. 6, 1955, in The Johns Hopkins University Hospital, Baltimore, Md. Born, Madison, Wis., June 8, 1904. Parents, Willis P. and Jane (Grimm) Colburn. Education, BS(ChE), University of Wisconsin, 1926; MS(ChE), 1927; PhD, 1929. Married Evelyn Safford, 1931. Since 1948 he had been consultant to Research and Development Board, Department of Defense. Recipient Walker Award, AIChE, 1936; Professional Progress Award, AIChE, 1948 (first recipient). Mem. ASME, 1944. He served the Society in the Heat Transfer Division as follows: Member, Technical Committee on Unfired Heat Transfer Equipment, 1944–1947; member, Special Advisory Committee on Heat Exchange Research, from 1947; member, Executive Committee, 1943–1948; and chairman, Executive Committee and of the Division, 1948. A nationally recognized authority in chemical engineering, he was author of many publications. His papers dealt with heat transfer, fluid-flow distillation, absorption and extracting, and other varied technical subjects. He wrote several textbooks. Survived by wife; three children, Judith E., Willis S., Carolyn F.; and his mother. He was an IME Clayton Lecturer.

Thomas Edward Coon (1925–1955), project engineer, Aircraft Engineering Division, Studebaker-Packard Motor Car Co., Detroit, Mich., died Jan. 15, 1955. Born, Hancock, Mich., Feb. 10, 1925. Education, BME, University of Detroit, 1950. Assoc. Mem. ASME, 1954. Survived by wife; two children, Marjorie and Patrick.

Arthur Preston Cottle (1875–1954), formerly head, Materials and Standards Division, International Harvester Co., Chicago, Ill., died Jan. 24, 1954, according to a notice recently received by the Society. Born, Boston, Mass., Sept. 26, 1875. Parents, William A. and Annie K. Cottle. Education, ME, Cornell University, 1907. Married Mildred Arnold, 1913; children, Mary Cottle Benedict and Richard A. Cottle. Mem. ASME, 1935. He held two patents on internal-combustion engines.

Orrie Pratt Cummings (1868–1955), retired vice-president, A. B. See Elevator Co., Inc., New York, N. Y., died Feb. 8, 1955. Born, Preble, N. Y., Oct. 26, 1868. Parents, Daniel M. and Climena (Pratt) Cummings. Education, EE, Cornell University, 1894. Married Gertrude Kellogg, 1900. Mem. ASME, 1899. Served the Society on the Safety Committee for Safety Code for Elevators since the inception of the Committee. He was president, Elevator Manufacturers Association of the United States, 1921–1922. Survived by wife.

Victor Raymond Gage (1882–1955), retired professor of mechanical engineering, Cornell University, died in Ithaca, N. Y., Jan. 12, 1955. Born, Vineland, N. J., Nov. 26, 1882. Parents, Asahel and Helen (Shepard) Gage. Education, ME, Cornell University, 1906; MME, 1910. Married Helen Heath, 1908; daughter, Helen V. Mem. ASME, 1936. Author of "A Study of Airplane Engines," several reports of the National Advisory Committee for Aeronautics, and various technical articles.

J. Houston Harrison (1887–1954), mechanical engineer, valuation and research department, Southern Railway System, Washington, D. C., died Nov. 1, 1954. Born, Rockingham Co., Va., July 8, 1887. Parents, David W. and Anna A. (Houston) Harrison. Education, attended Ohio Northern University; ME, University of Virginia, 1910. Married Berta S. Watson; children Anna L. (Mrs. H. P. Shaffer), Pearl E. (Mrs. R. E. Craddock), John H., David W., Daniel E., Nancy B. (Mrs. C. E. Gibb). Mem. ASME, 1923. He held patents on rotary steam engines.

David Schenck Jacobus (1862–1955), engineer, educator, authority in steam engineering, and internationally famous test engineer of power-plant equipment, died Feb. 11, 1955. Born, Ridgefield, N. J., Jan. 20, 1862. Parents, Nicholas and Sarah C. (Carpenter) Jacobus. Education, ME, Stevens Institute of Technology, 1884; hon. DE, 1906. Married Laura Dinkel, 1899. Recipient of Morehead Medal from International Acetylene Association, 1935; Miller Medal, American Welding Society, 1943; selected a National Modern Pioneer by National Association of Manufacturers, 1940. Author many technical papers. He had been awarded 188 patents pertaining to boilers, furnaces, and superheaters. Mem. ASME, 1889, joined the Society as a student and was present at the organization meeting in 1880. Hon. Mem. ASME, 1934. He served the Society as Manager, 1900–1903; Vice-President, 1903–1905; and President, 1916. He served on standing and special ASME committees without number. Particularly, his work on the Boiler Code Committee has reflected great credit on the Society. In 1917 he was made chairman of Executive Committee and vice-chairman of Boiler Code Committee and the following year was appointed a member of the ASME Committee on Power Test Codes. He held membership or honorary membership in more than five of the leading professional societies and served as president in two. He presented papers at the First World Power Conference in London, 1924; The World Power Conference in Japan, 1929; and The Round Table Conference at Philadelphia, Pa., 1936. Dr. Jacobus, a life member of the Stevens Institute of Technology Board of Trustees, had the unique honor of having had built in his honor, during his lifetime, a monument in the form of a building known as Jacobus Hall at the Institute. Survived by daughter, Mrs. Fred A. Muschenheim; son, David D.; and two grandsons, Dr. David P. Jacobus and John H. Jacobus.

John James Janak, Jr. (1905–1954), superintendent of Power, Texas Power & Light Co., Dallas, Texas, was killed in an automobile accident, December, 1954. Born, Weimar, Texas, Aug. 30, 1905. Education, BS(ME), A&M College of Texas, 1930. Mem. ASME, 1951.

(*ASME News continued on page 482*)

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J. Adolph Johnson (1879–1954), factory manager, Bade-Cummins Manufacturing Co., Louisville, Ky., died Dec. 24, 1954. Born in Sweden, June 8, 1879. Education, high-school graduate, home study, and correspondence-school courses. Mem. ASME, 1916. Survived by wife.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult the form on this page for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions' enrollment are correct. Please check whether you wish mail sent to home or office address.

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Publication	*Address changes effective when received prior to:*
☐ Mechanical Engineering	10th of preceding month
☐ Transactions of the ASME	20th of preceding month
☐ *Journal of Applied Mechanics*	20th of preceding month
☐ *Applied Mechanics Reviews*	1st of preceding month

Please register me in three Professional Divisions as checked:

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☐ S—Power
☐ T—Textile
☐ V—Gas Turbine Power
☐ W—Wood Industries
☐ Y—Rubber and Plastics
☐ Z—Instruments and Regulators

Daniel Edward Kehoe (1886–1954), plant operator, filtration plant, Water Department, City of Savannah (Ga.), died March 21, 1954. Born, Savannah, Ga., Jan. 23, 1886. Parents, William and Anna (Flood) Kehoe. Education, Steven School, 1906–1907; IME, Pratt Institute, 1910. Married Barbara Byers, 1924. Mem. ASME, 1945. Survived by wife.

Toby Emanuel Levinson (1927–1954), junior design engineer, Goodyear Tire & Rubber Co., Los Angeles, Calif., died June 13, 1954. Born, Chicago, Ill., March 15, 1927. Education, University of Illinois, 1946–1948; BS, University of California at Los Angeles, 1950. Junior ASME, 1952. Survived by wife.

Walter J. Mark (1886–1955), retired engineer of Los Angeles, Calif., died in February, 1955. Born, St. Paul, Minn., March 14, 1886. Education, ME, University of Minnesota, 1909. For some time during his career he was with the National Housing Agency. Mem. ASME, 1926.

William Adams Montgomery (1919–1954), design draftsman, Diesel Division, American Bosch Corp., Springfield, Mass., died Oct. 26, 1954. Born, North Adams, Mass., Aug. 22, 1919. Education, BS(ME), Northeastern University, 1943. Jun. Mem. ASME, 1943.

Norman Eric Olson (1916–1954), engineering draftsman "B," North American Aviation, Inc., Los Angeles, Calif., was drowned while on a visit to Ensenada, Mexico, Sept. 26, 1954. Born, Los Angeles, Calif., Sept. 30, 1916. Education, BSME, California Institute of Technology, 1948. Jun. ASME, 1948.

George Ruel Paugh (1887–1954), sales engineer, The Babcock & Wilcox Co., New York, N. Y., died Aug. 13, 1954. Born, Newark, N. J., Nov. 17, 1887. Education, 2 years, Stevens Institute. Mem. ASME, 1923. Survived by wife, Marguerite S. Paugh.

Stephen Pigott (1880–1955), managing director, John Brown & Co., Ltd., Clydebank, Glasgow, Scotland, died at his home in Dumfriesshire, Feb. 27, 1955. Born, Cornwall, N. Y., Jan. 30, 1880. Education, completed courses in mechanical and marine engineering, Columbia University, 1903 and became a resident of Britain in 1908. Married Mary Lewis Thatcher, 1907, died 1943; children, one son and four daughters. Married 2nd, Mrs. Dorothy Wright McWharrie, widow of Neil Matheson McWharrie. He became a British subject when he was knighted in 1939 for his work in developing the engines that power the British transatlantic liners, *Queen Mary* and *Queen Elizabeth*, both of which were built by John Brown and Co. In 1938 he received the ASME Medal for outstanding leadership in marine propulsion and construction. One of Sir Stephen's four daughters, Nancy Patterson Pigott, was married to Estes Kefauver, U. S. Senator from Tennessee, in 1935.

Robert Arthur Rankin (1899–1954), president, The Rankin Co., Ltd., Montreal, Que., Can., died Aug. 14, 1954. Born, Glasgow, Scotland, Nov. 19, 1899. Education, Bellahouston Academy, Glasgow; Royal Technical College, Glasgow; BS (mechnical and electrical), dipl. RTC, University of Glasgow, 1924. Mem. ASME 1940.

Hugh Welshman, Jr. (1911–1955), manager, Industrial Piping Division, Grinnel Co., Inc., Providence, R. I., died Jan. 1, 1955. Born, Providence, R. I., May 29, 1911. Education, BS(ME), Brown University, 1934. Mem. ASME, 1944. An authority in the design of complete piping systems, he was assigned by the Grinnel Co. in 1941–1943 to design the process piping, heating, ventilation, and dust control for a tire plant installed in Russia and furnished by U. S. Treasury Lend-Lease.

Hamilton M. Wilson (1888–1955), owner, H. M. Wilson Co., Philadelphia, Pa., died Feb. 22, 1955. Born, Philadelphia, Pa., Aug. 9, 1888. Parents, James H. and Katherine (Heinzer) Wilson. Education, high-school graduate; 3 years, Columbia University. Married Ida C. Coles, Mem. ASME, 1930.

Basil Woynar 1899–1954), squad leader, design department, Combustion Engineering, Inc., East Chicago, Ind., died June 24, 1954. Born, Kronstadt, Russia, Feb. 20, 1899. Education, 7 years, Russian Reale School, 1909–1916; 2 years, Russian Naval Engineering Academy, 1916–1918; commissioned assistant ship engineer, ME, Polish Naval Engineering Academy, 1920–1923; postgraduate studies at University of Wisconsin, City College of New York, and Illinois Institute of Technology. Mem. ASME, 1945.